

Living Shorelines 101

Challenges and Opportunities in California



Marilyn Latta, Project Manager
California State Coastal Conservancy



Climate Ready Webinar
3/30/17

Webinar Agenda

1. Living Shorelines Overview — Marilyn Latta
Need, Definition, Considerations

2. Case Studies in CA — Evyan Sloane, Joel Gerwein
Oyster, Eelgrass, Beaches, Dunes- Evyan Sloane
Tidal Wetlands- Joel Gerwein

3. Challenges & Opportunities in CA — Marilyn Latta
Policy and Regulatory Considerations

4. Questions

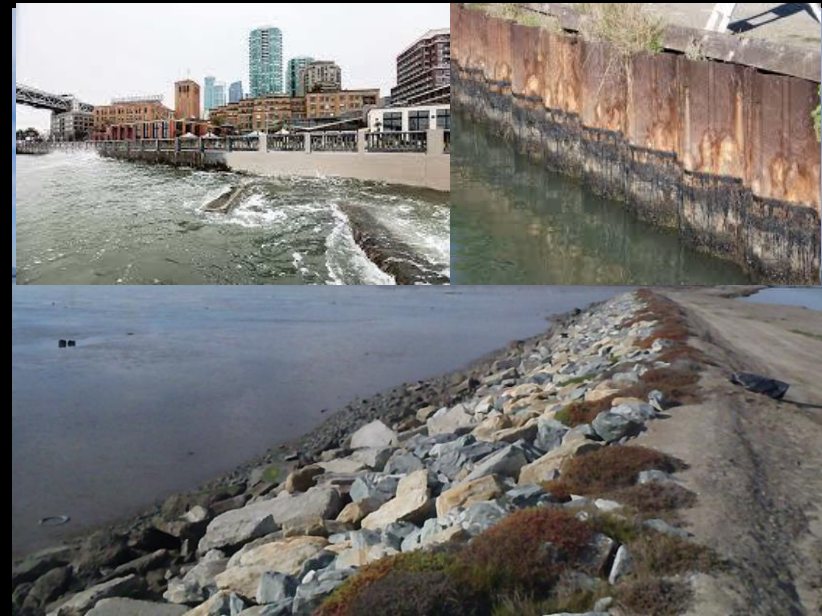


Audience Polling



Hard Infrastructure

**Necessary in certain locations
Impacts to shorelines, wetlands
and subtidal habitats**



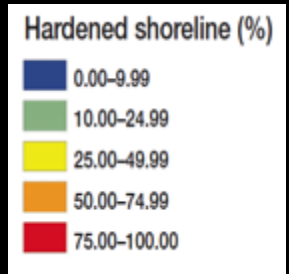
Nature-Based Infrastructure

**Biological and Physical Benefits
Habitat Connectivity
Climate Adaptation**

A Legacy of Shoreline Hardening



14% of U.S. shoreline is hardened



What are the ecological consequences of shoreline hardening?



Affected flora and fauna

- Benthic infauna (e.g., Seitz et al. 2006)
- Shore birds (e.g., Dugan et al. 2006, 2008)
- Nekton (Peterson et al. 2000, Gittman et al. 2016, Seitz et al. 2006)



Shoreline access and uses





Living Shorelines

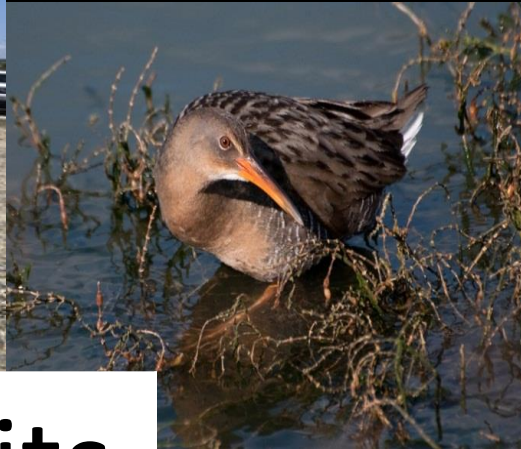
Living Shorelines can include any **shoreline management system** that is **designed to protect or restore natural shoreline ecosystems** through the use of natural elements and, if appropriate, manmade elements.



Living Shoreline Principles

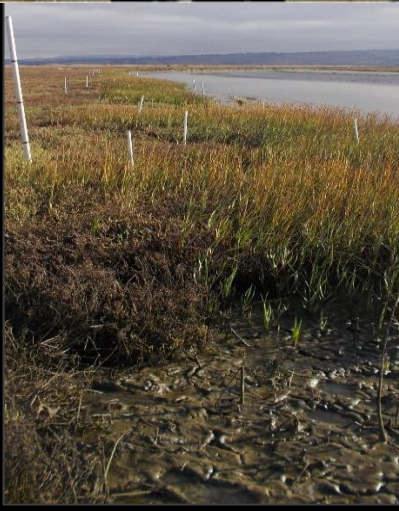
- Restoration with multiple objectives
 - Reduce shoreline erosion
 - Maintain coastal processes
- Protect and enhance habitat values for fish and wildlife
- Adapt to sea level rise and climate changes
- Link to regional habitat recommendations





Multiple Co-Benefits

- Create Fish and Wildlife Habitat
- Attenuate Wave Energy
- Accrete Sediment
- Reduce Erosion
- Can Provide Outdoor Recreation
- May Sequester Carbon
- May Buffer Ocean Acidification



Soft Shorelines Green Infrastructure Nature-based Adaptation ...



Any elements used must not interrupt the natural water/land continuum to the detriment of natural shoreline ecosystems.

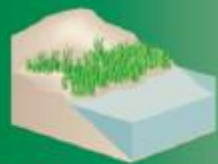


Green-Grey Spectrum for Living Shorelines

GREEN - SOFTER TECHNIQUES

GRAY - HARDER TECHNIQUES

Living Shorelines



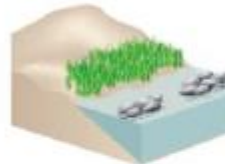
VEGETATION ONLY -
Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.



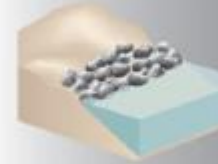
EDGING -
Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.



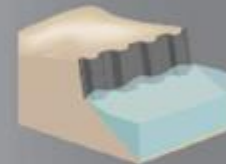
SILLS -
Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.



BREAKWATER -
(vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.



REVETMENT -
Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.



BULKHEAD -
Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

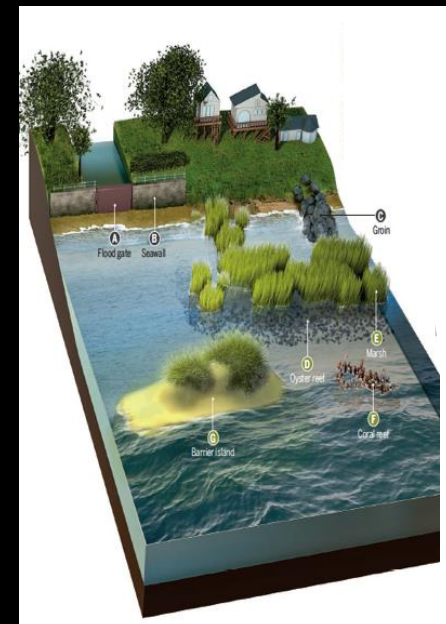
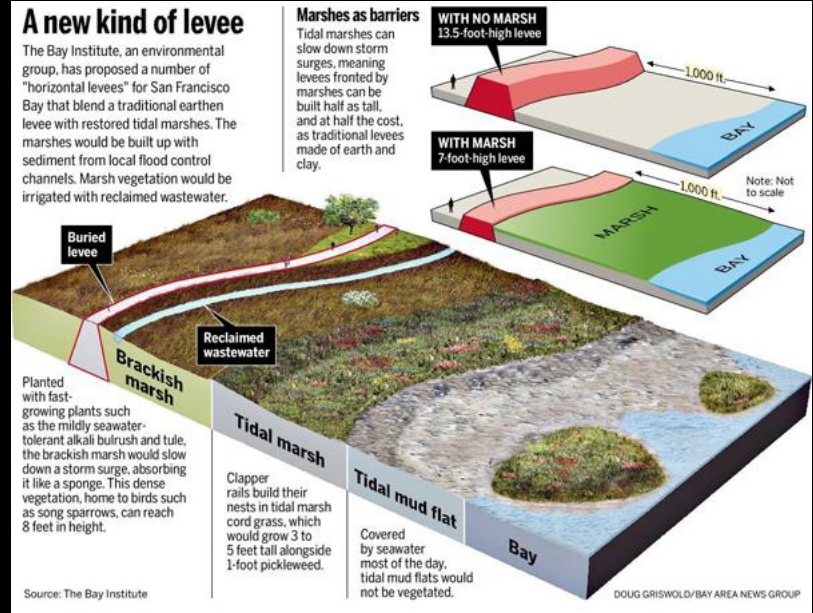
Recent Innovation & Popularization of “Living Shorelines”



BREAKING THE WAVES

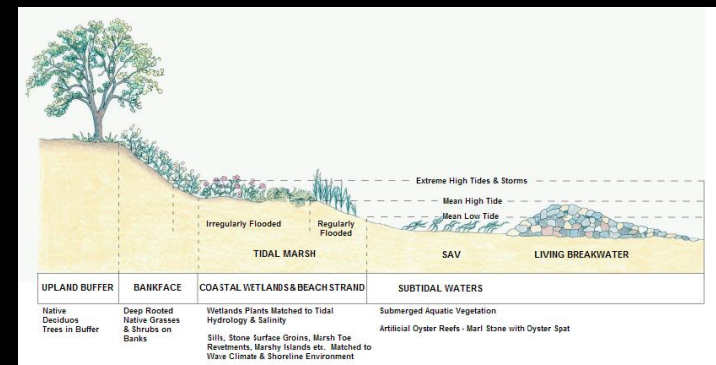
As a defense against rising seas, shorelines made of marsh grasses and oyster reefs may work better than concrete armor

By Gabriel Popkin Photography by Dylan Ray



East and Gulf Coast Projects

- protection of private shorelines
- short linear length, high intertidal
- lack of monitoring data
- increased funding- BP oil spill



Maryland Living Shorelines Protection Act of 2008

Policy/Permitting Support

- Virginia
- North/ South Carolina
- Alabama
- Mississippi



Project Example: *North Carolina Coastal Federation*
Activity: *Crassostrea virginica* reef installations

- shell recycling program with local restaurants
- volunteers bag shell for reef building
- barge operators volunteer for hydroshell method



Protection from Hurricanes, Erosion



Sea Wall - Before



Sea Wall - After



Living Shoreline- Before



Living Shoreline- After

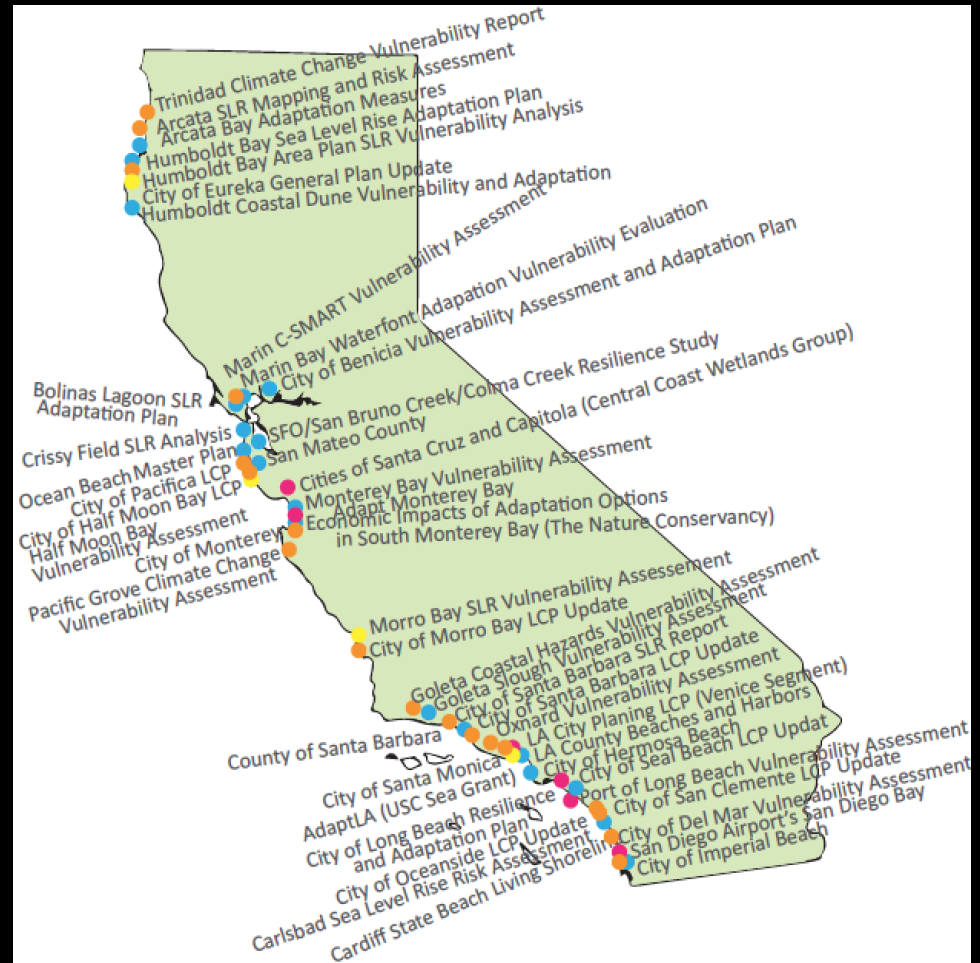
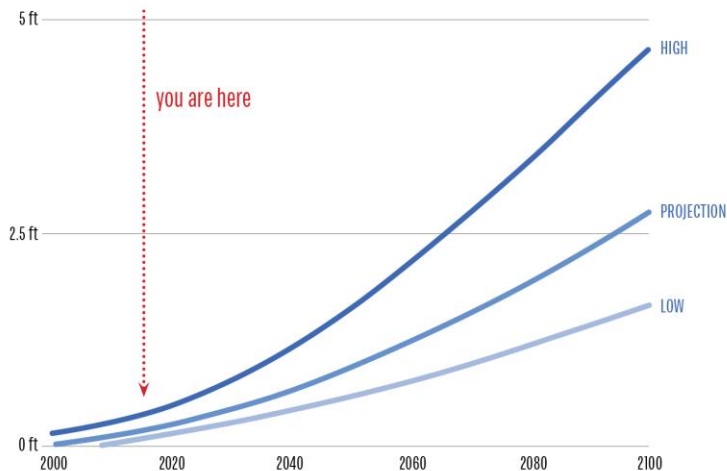
At Risk In California:

- 1.4M SLR – 480,000 people
- Property valued at \$1B
- Habitats and Species



SEA LEVEL *rise* FOR CALIFORNIA

Courtesy NRC 2012





SOUTHERN CALIFORNIA WETLANDS RECOVERY PROJECT



San Francisco Bay Subtidal Habitat Goals Report

CONSERVATION PLANNING FOR THE SUBMERGED AREAS OF THE BAY

50-YEAR CONSERVATION PLAN • 2018

CALIFORNIA STATE COASTAL CONSERVANCY AND OCEAN PROTECTION COUNCIL
NORCA NATIONAL MARINE FISHERIES SERVICE AND RESTORATION CENTER
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
SAN FRANCISCO ESTUARY PARTNERSHIP

THE *Baylands* AND *Climate Change*

WHAT WE CAN DO

BAYLANDS ECOSYSTEM HABITAT GOALS
SCIENCE UPDATE 2019

NATURAL DEFENSES IN ACTION

HARNESSING NATURE TO PROTECT OUR COMMUNITIES



ALLIED
WORLD

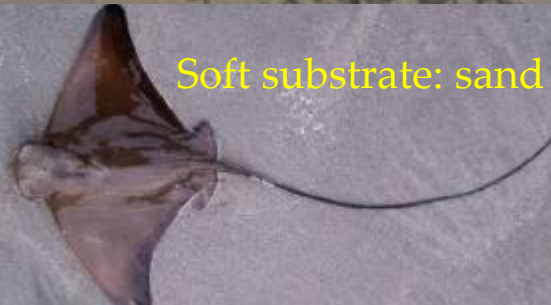




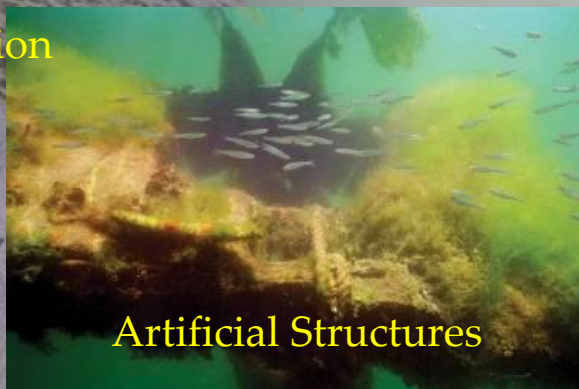
Tidal wetlands



Submerged Aquatic Vegetation



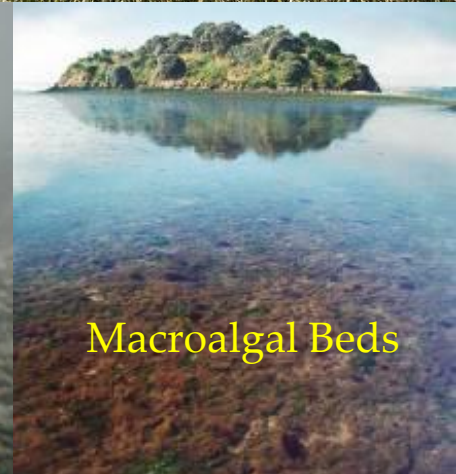
Soft substrate: sand



Artificial Structures



Rock Habitats



Macroalgal Beds



Shellfish Beds



Soft Substrate: Mud/ shell mix





Coastal Scrub



Coastal Bluffs



Headlands



Kelp and Seaweed Beds



Coastal Dunes



Beaches

One Size Does Not Fit All



- Design for specific conditions
- Substrate/ soil
 - Wave energy/ orientation
 - Adjacent infrastructure



- Local support
- Government willingness
 - Community engagement



CA Living Shorelines

(Kelp, Oysters, Eelgrass, Dunes, Tidal Marsh)

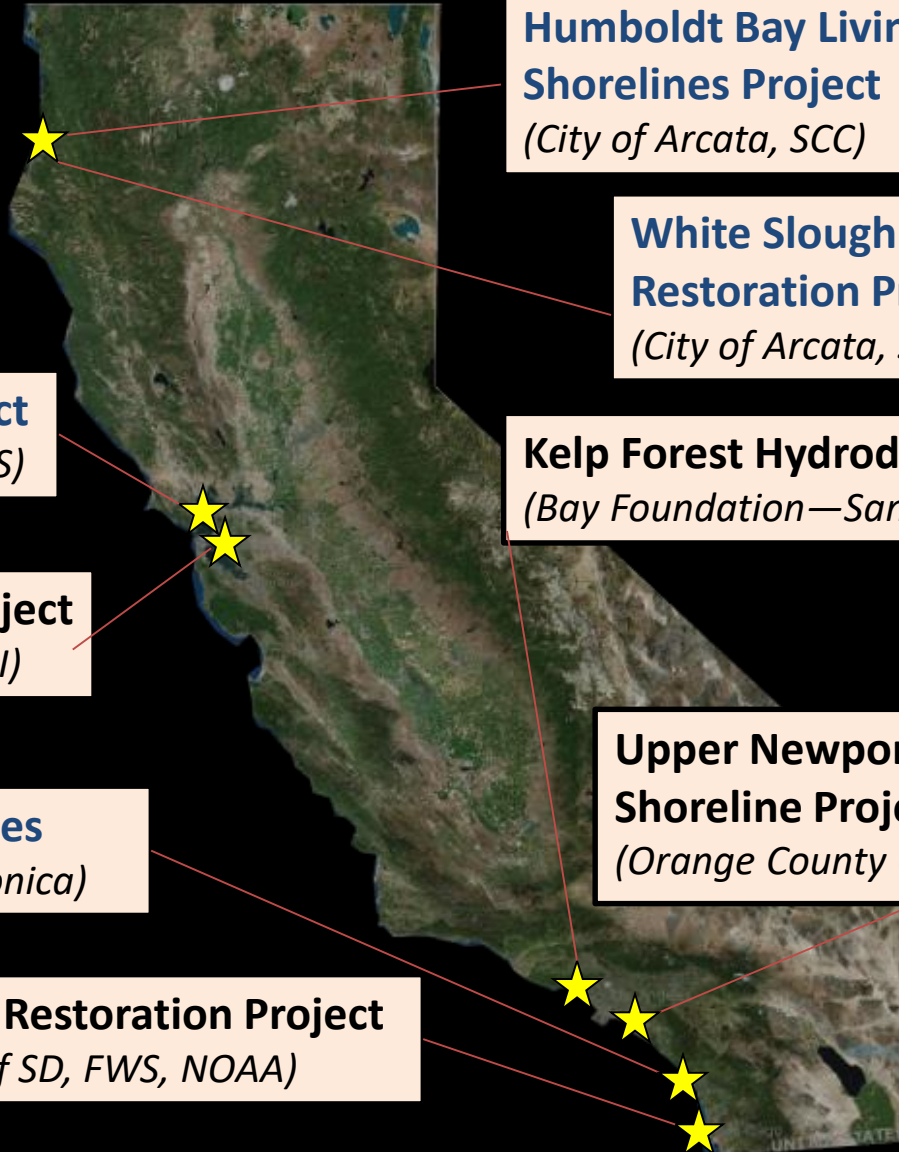


SF Bay Living Shorelines Project
(SCC, SF State, UC Davis, ESA, USGS)

Ora Loma Demonstration Project
(Sanitary District Save SF Bay, SFEI)

Cardiff Dunes Living Shorelines
(SCC, Bay Foundation—Santa Monica)

San Diego Bay Native Oyster Restoration Project
(SCC, SWIA, CSU Fullerton, Port of SD, FWS, NOAA)




Humboldt Bay Living Shorelines Project
(City of Arcata, SCC)

White Slough Restoration Project
(City of Arcata, SCC)

Kelp Forest Hydrodynamics Study
(Bay Foundation—Santa Monica)

Upper Newport Bay Living Shoreline Project
(Orange County Coastkeeper, SCC)



Living Shorelines Approaches in California

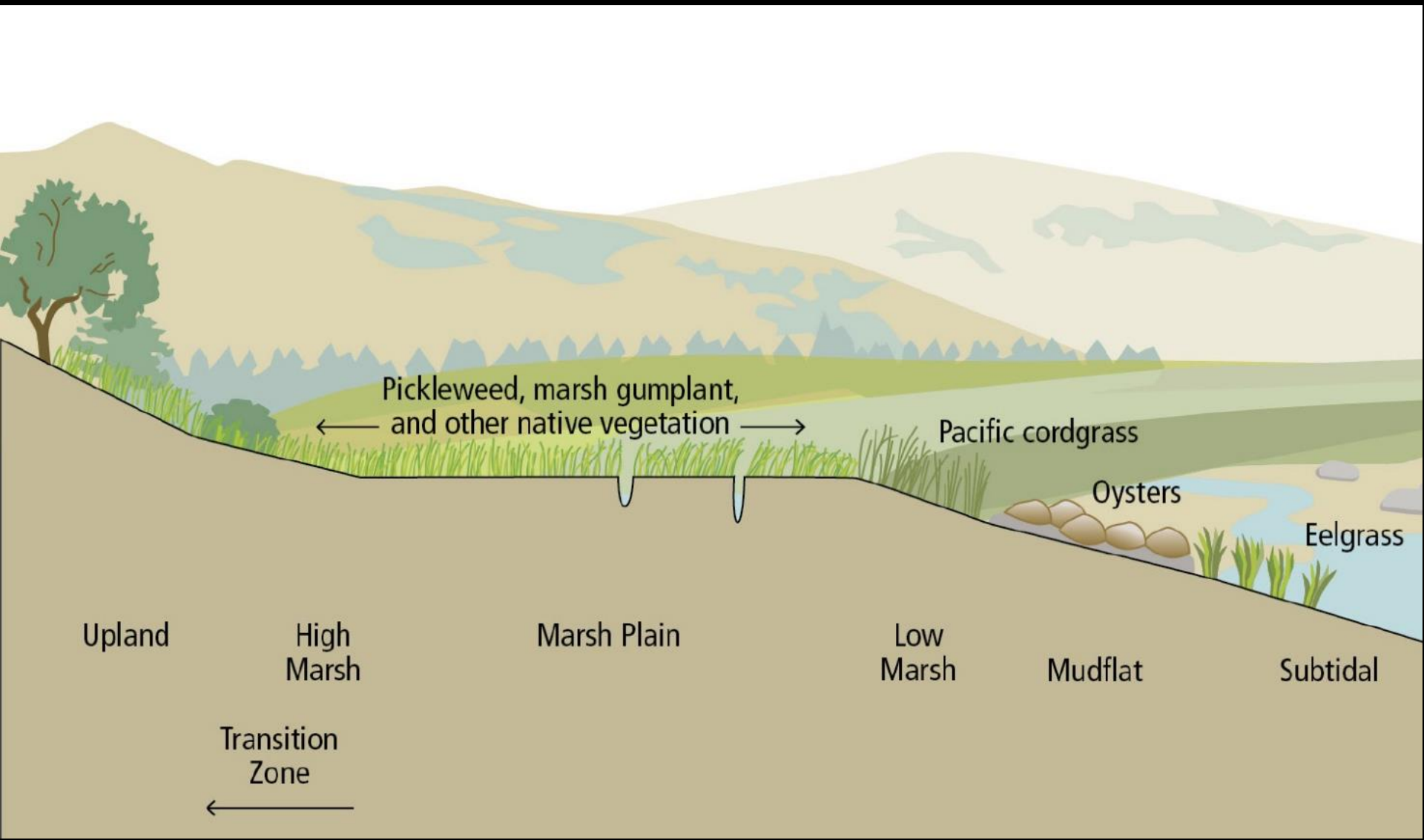
Evyan Borgnis Sloane



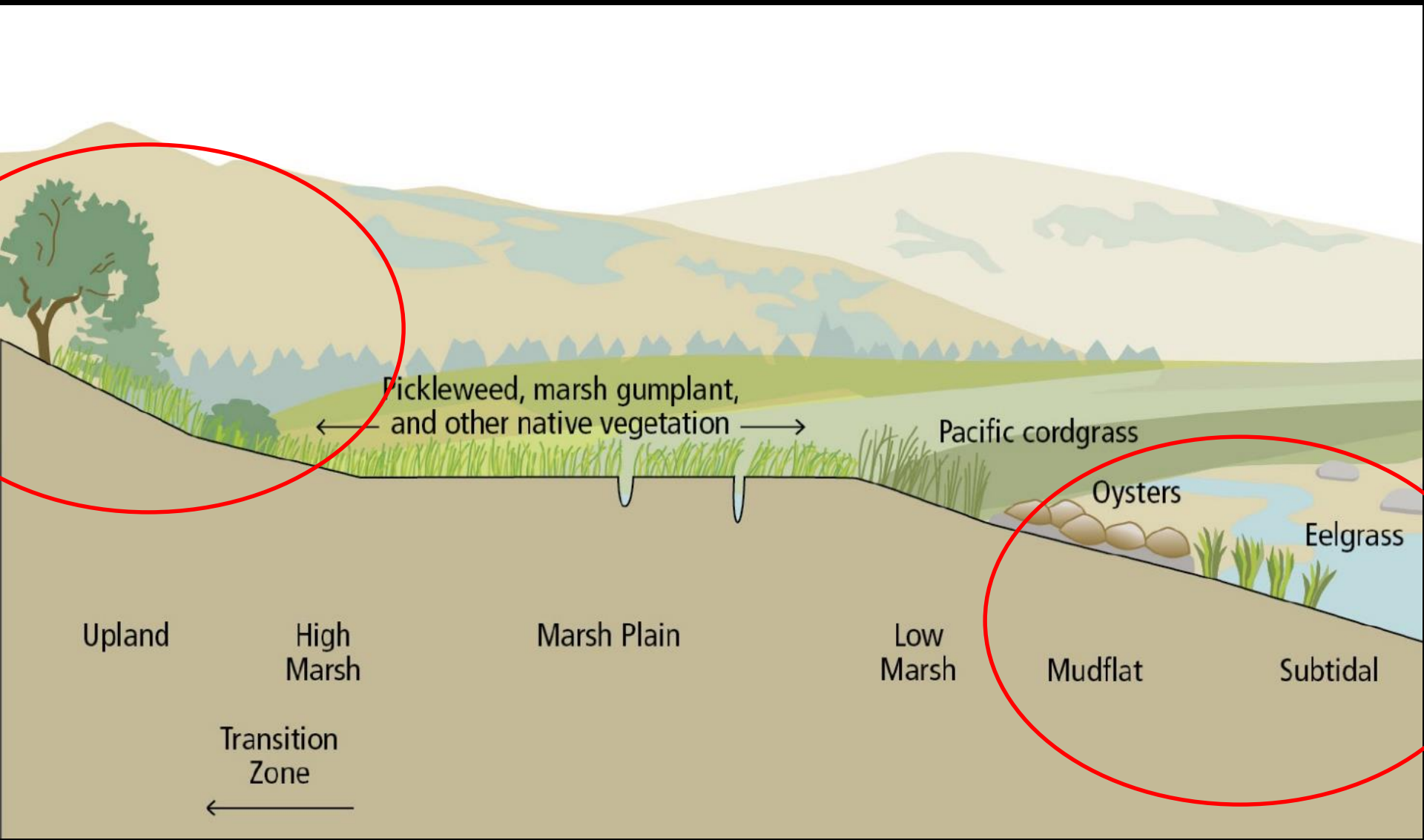
State of California

Coastal Conservancy

Many Coastal & Estuarine Habitats



Many Coastal & Estuarine Habitats



Living Shorelines

Subtidal (Oysters, Eelgrass, and Kelp)



SF Bay Living Shorelines Project
(SCC, SF State, and partners)



Upper Newport Bay Living Shoreline Project
(Orange County Coastkeeper)

Kelp Forest Hydrodynamics Study
(Bay Foundation—Santa Monica)

San Diego Bay Native Oyster Restoration Project
(SCC, SWIA, CSU Fullerton, Port of SD, FWS, NOAA)

San Francisco Bay Living Shoreline Project



SAN FRANCISCO
STATE UNIVERSITY

UC DAVIS



State of California
Coastal Conservancy



SF Bay Living Shoreline Project

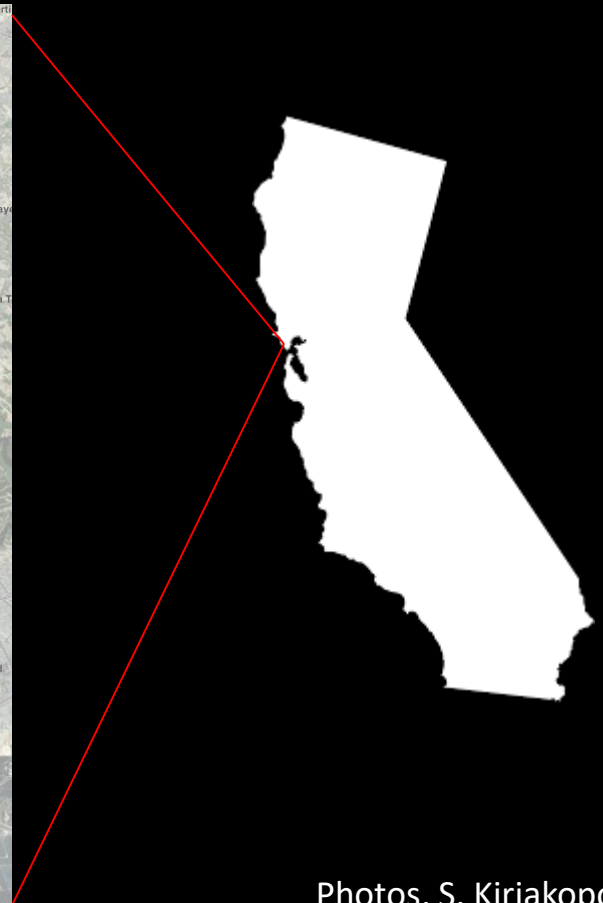
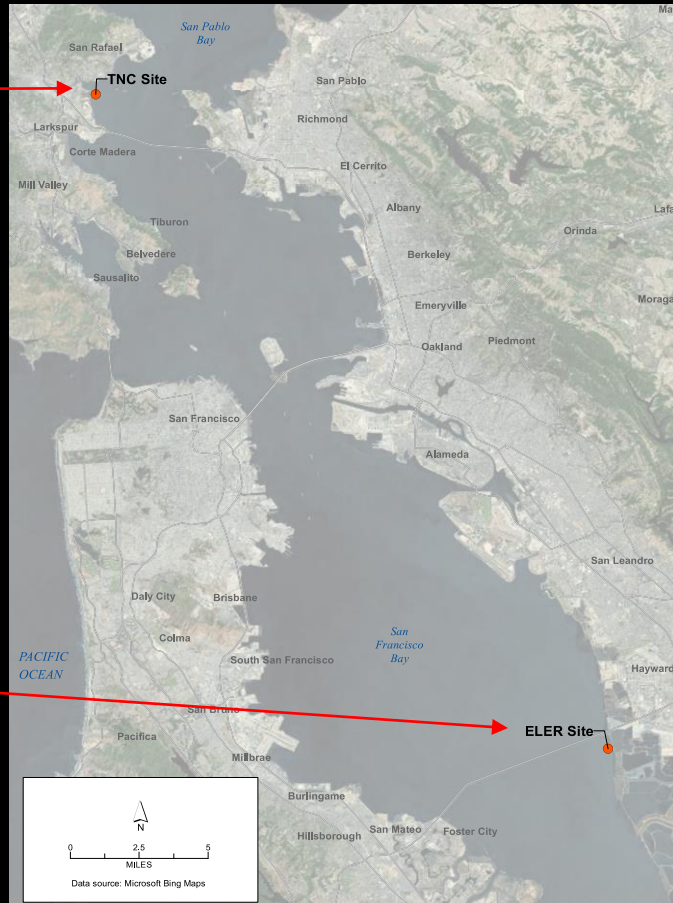
San Rafael



Hayward



California Department of
Fish and Wildlife

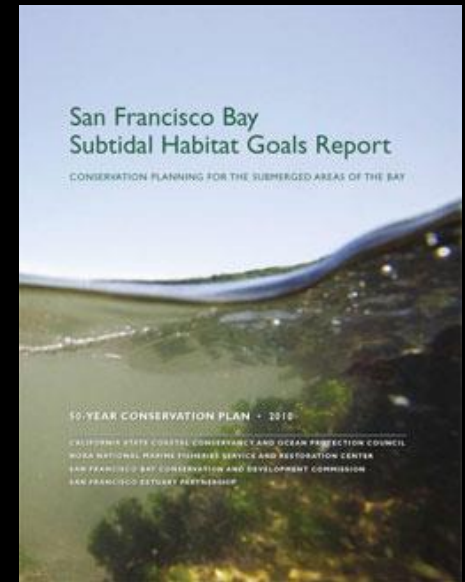


Photos, S. Kiriakopolos

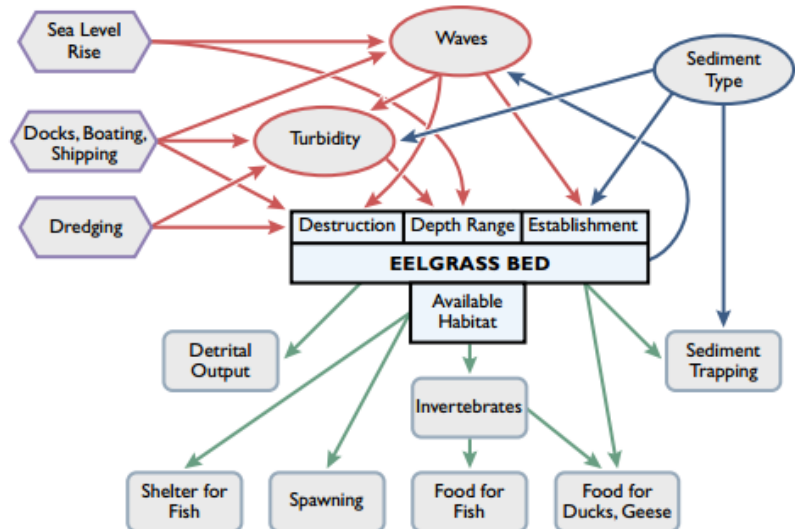
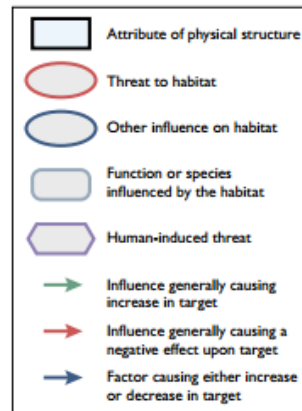
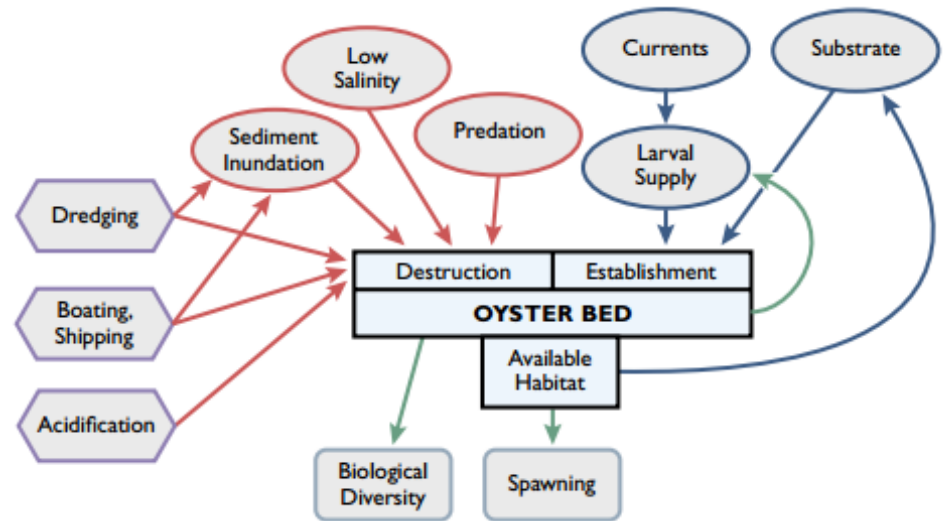
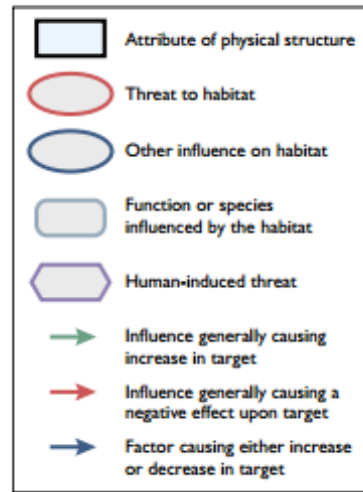


Multiple habitats & objectives

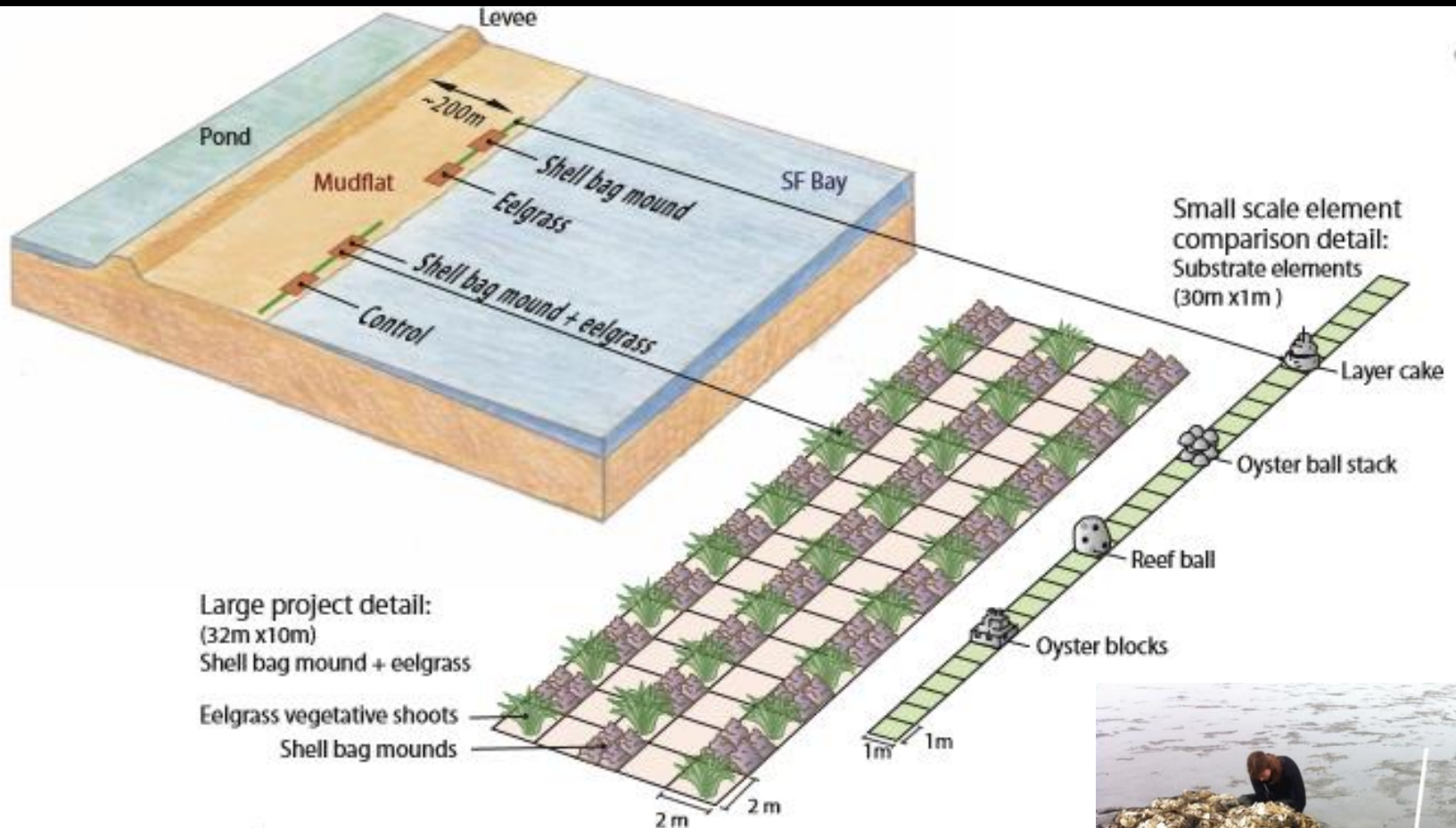
- Link to Subtidal Habitat Goals
- Pilot scale, **experimental** approach
- Monitoring invertebrates, fish, birds
- Assess **interactive effects** of oysters + eelgrass
- Evaluate physical benefits
- Pilot climate change adaptation
- Apply **lessons** learned



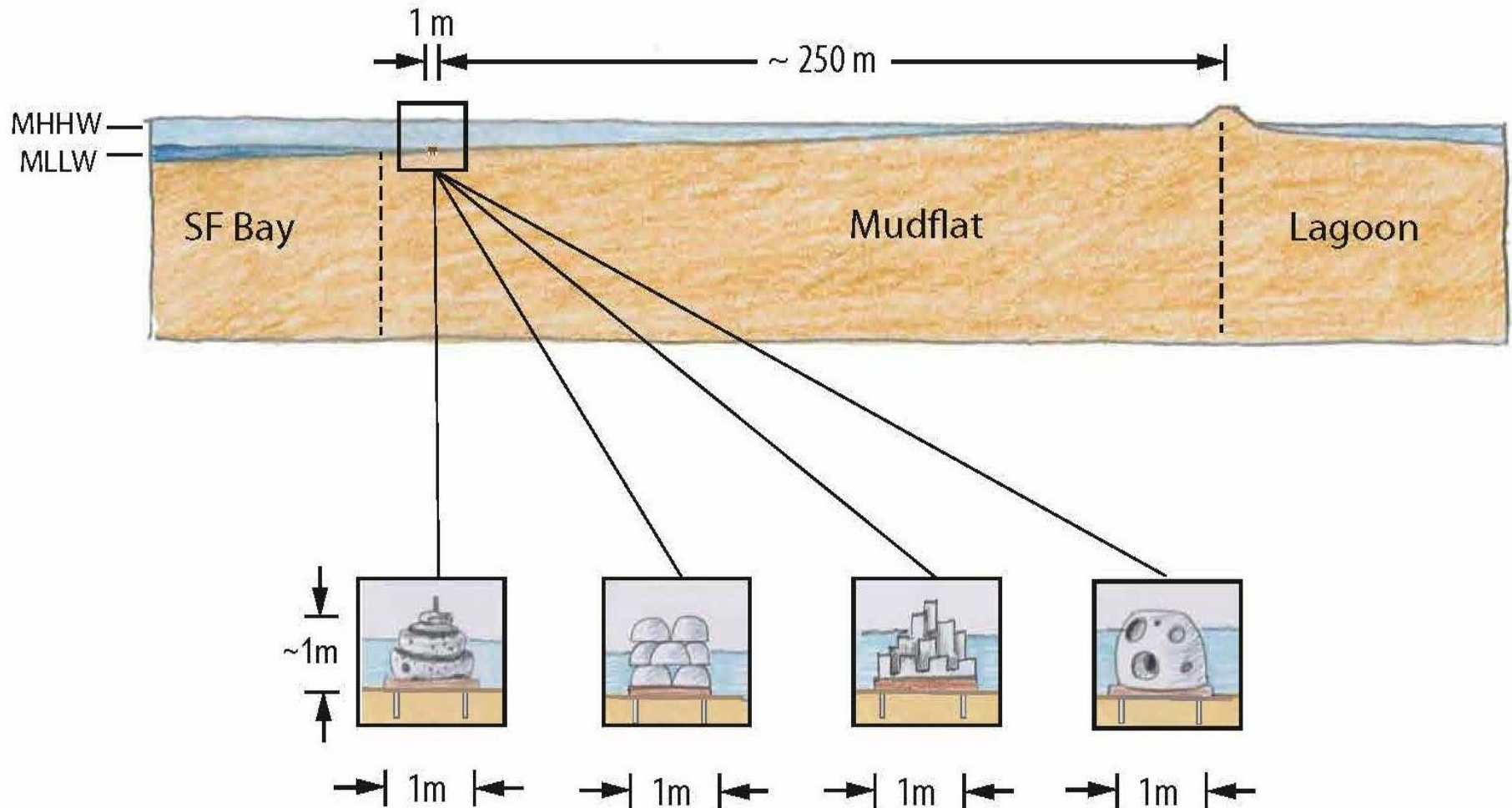
Multiple Benefits of Subtidal Habitat



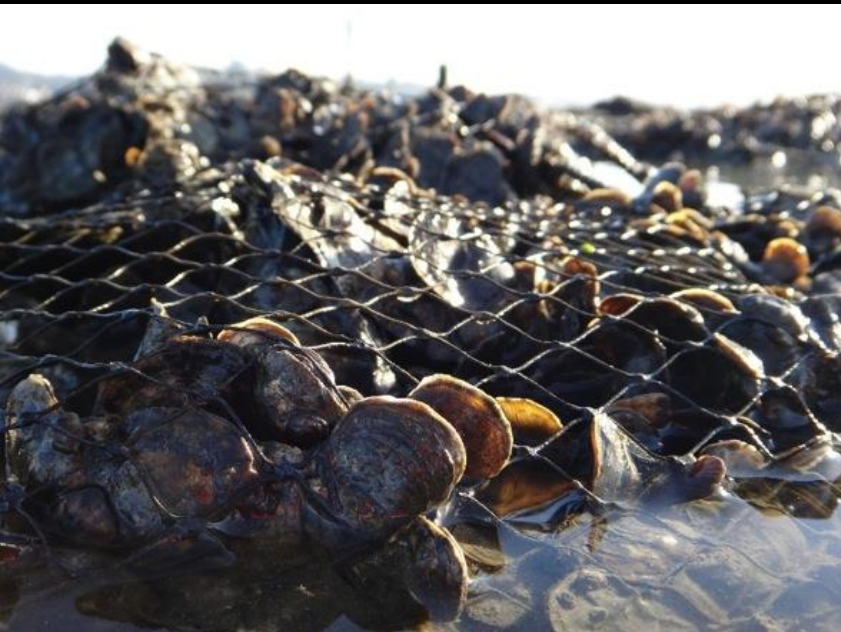
Design of Larger-scale Project



Smaller-scale test of “Baycrete”



In first year, >2 million oysters present on shell mounds!



UC DAVIS
UNIVERSITY OF CALIFORNIA

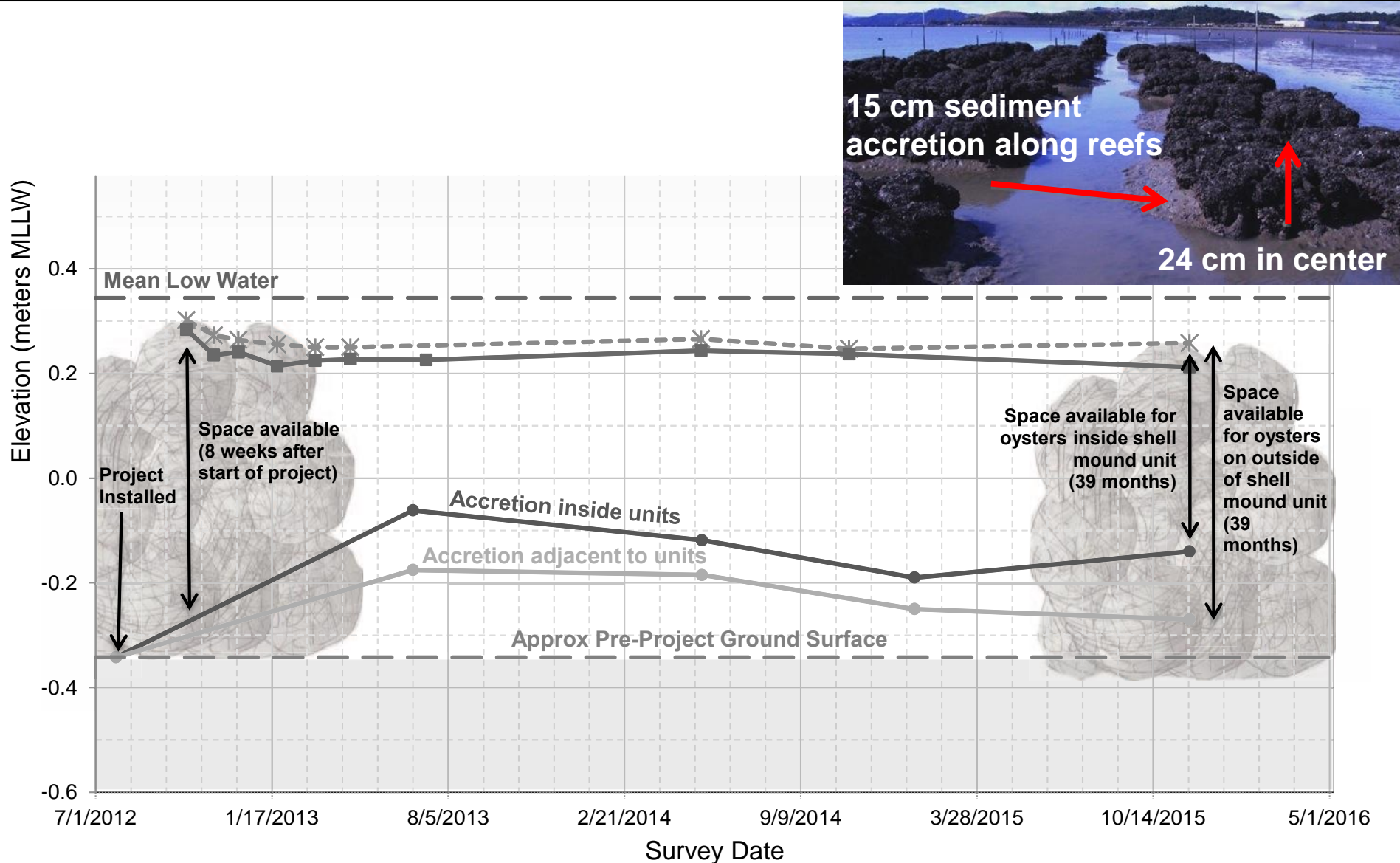
Photos, S. Kiriakopoulos

So much life out there!

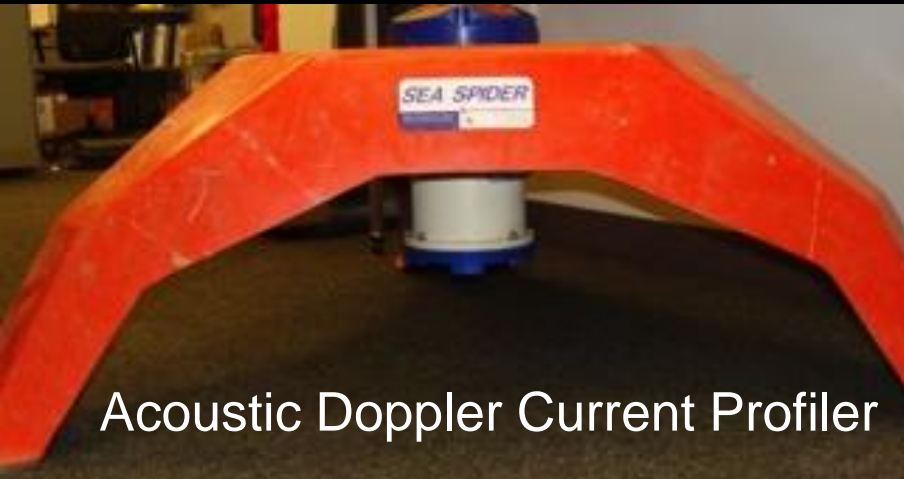


Photos, S. Kiriakopolos

Physical Changes



Physical Changes



Acoustic Doppler Current Profiler

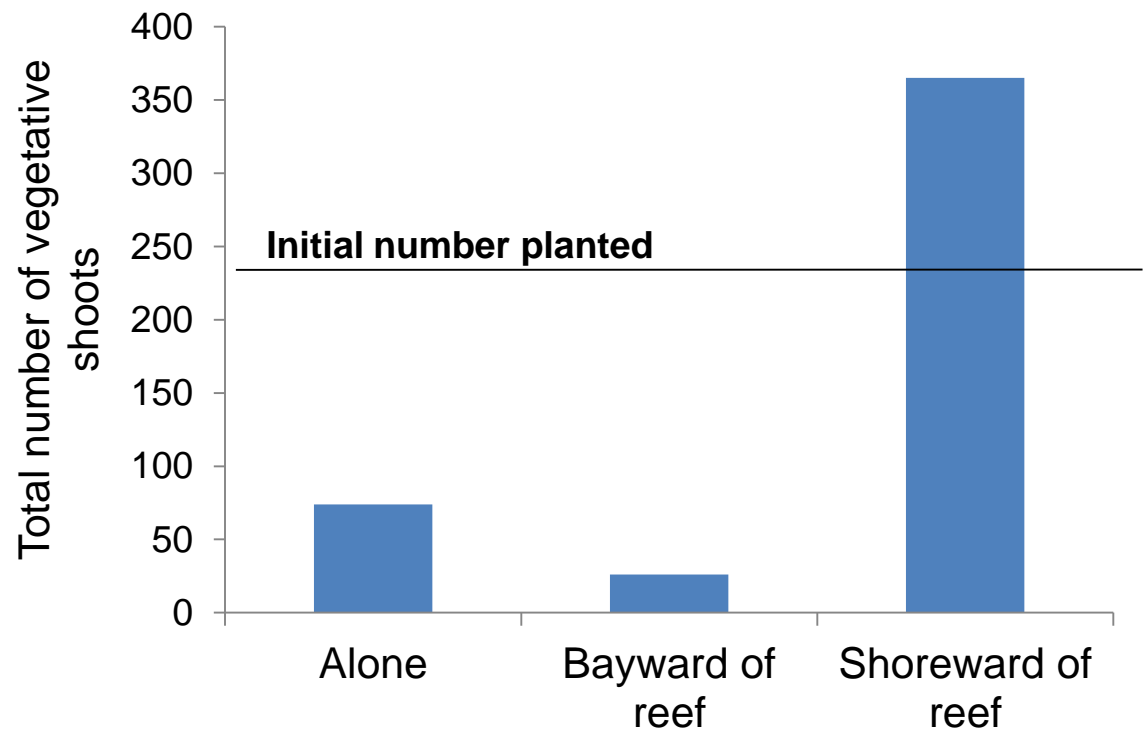


Most energy lost on broad mudflat, but reef extracts 30% more at mean tide levels

Eelgrass Densities – Second Planting

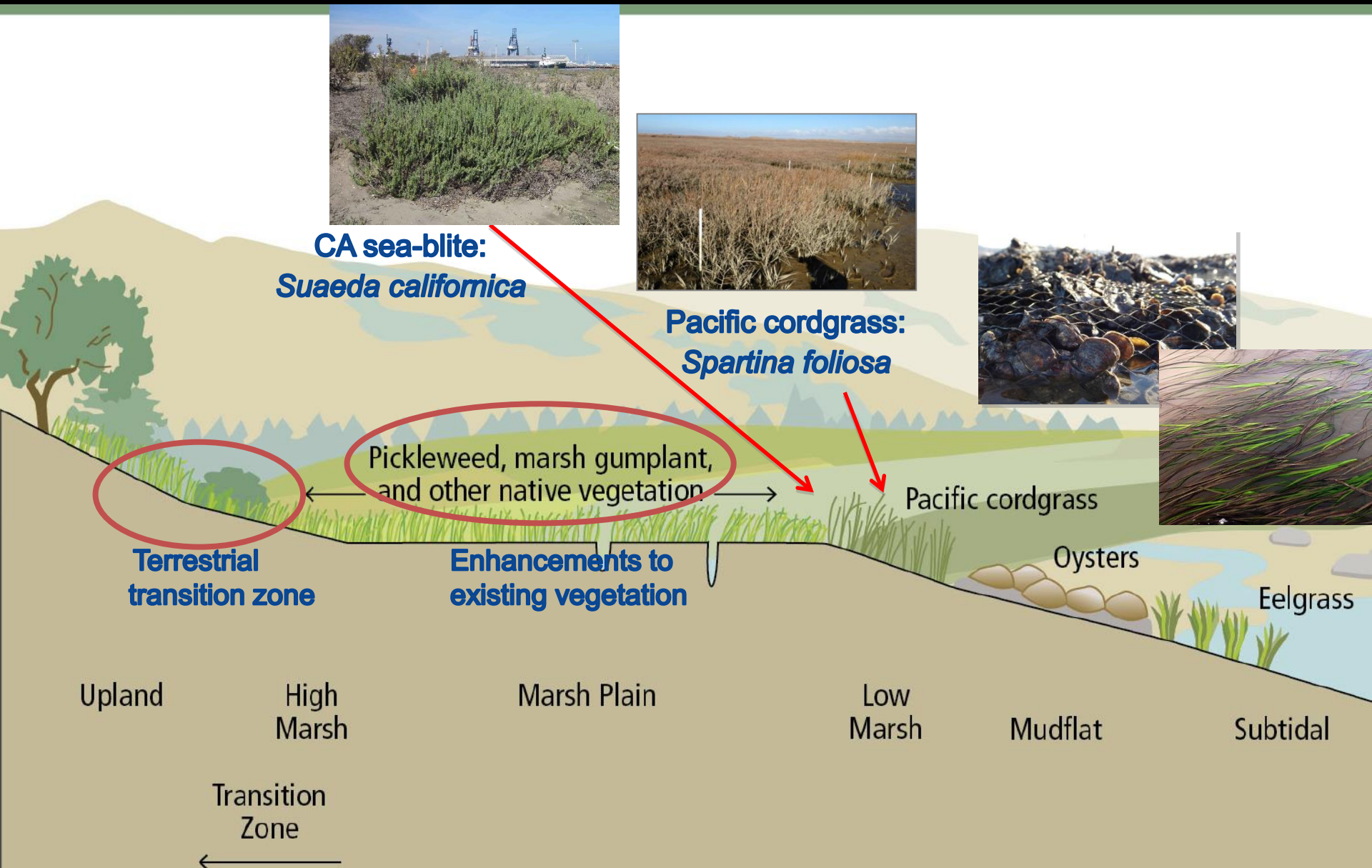


After 3 months, shoreward side of reef: much higher shoot numbers



Planning for new project underway: Giant Marsh

More habitat types, across complete shoreline gradient

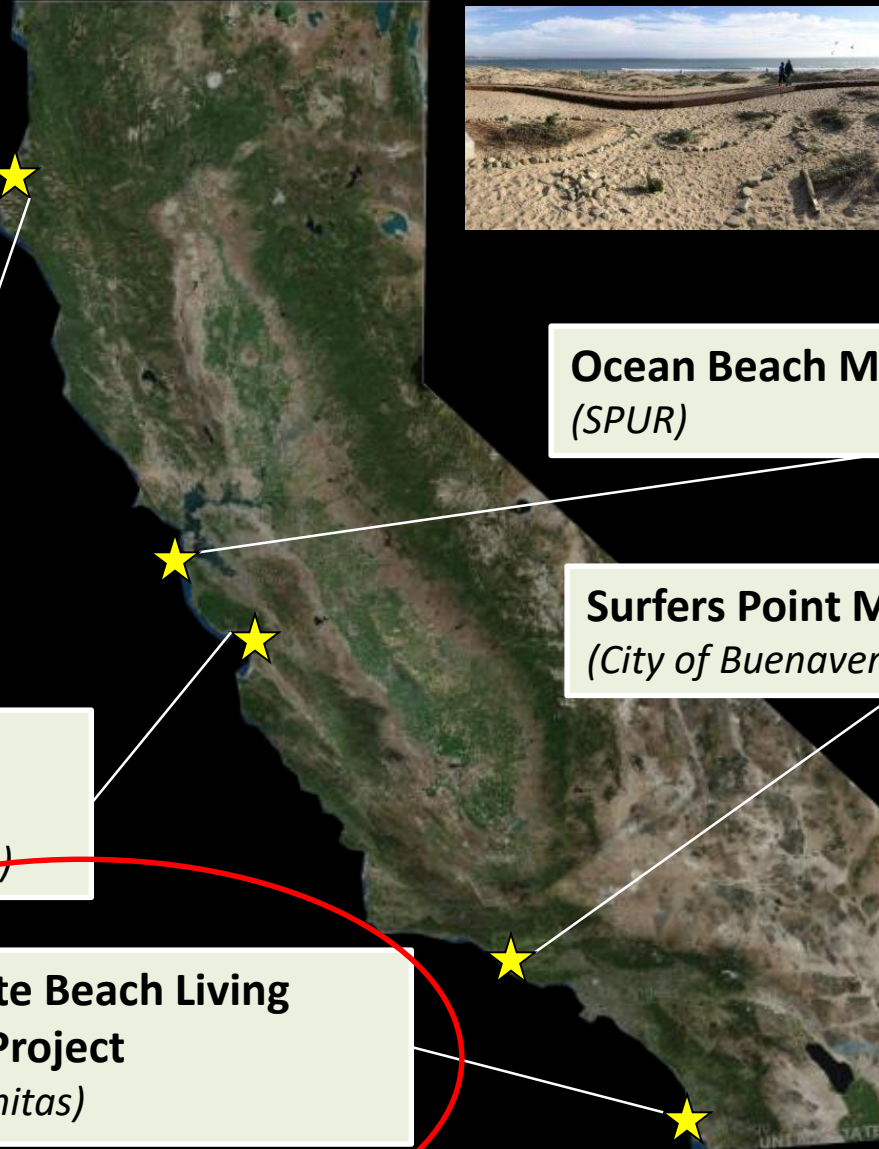




Humboldt Coastal Dune Vulnerability and Adaptation Project
(Friends of the Dunes)



Ocean Beach Master Plan
(SPUR)



Surfers Point Managed Retreat
(City of Buenaventura)

Salinas River State Beach Dune Restoration
(Central Coast Wetlands Group)

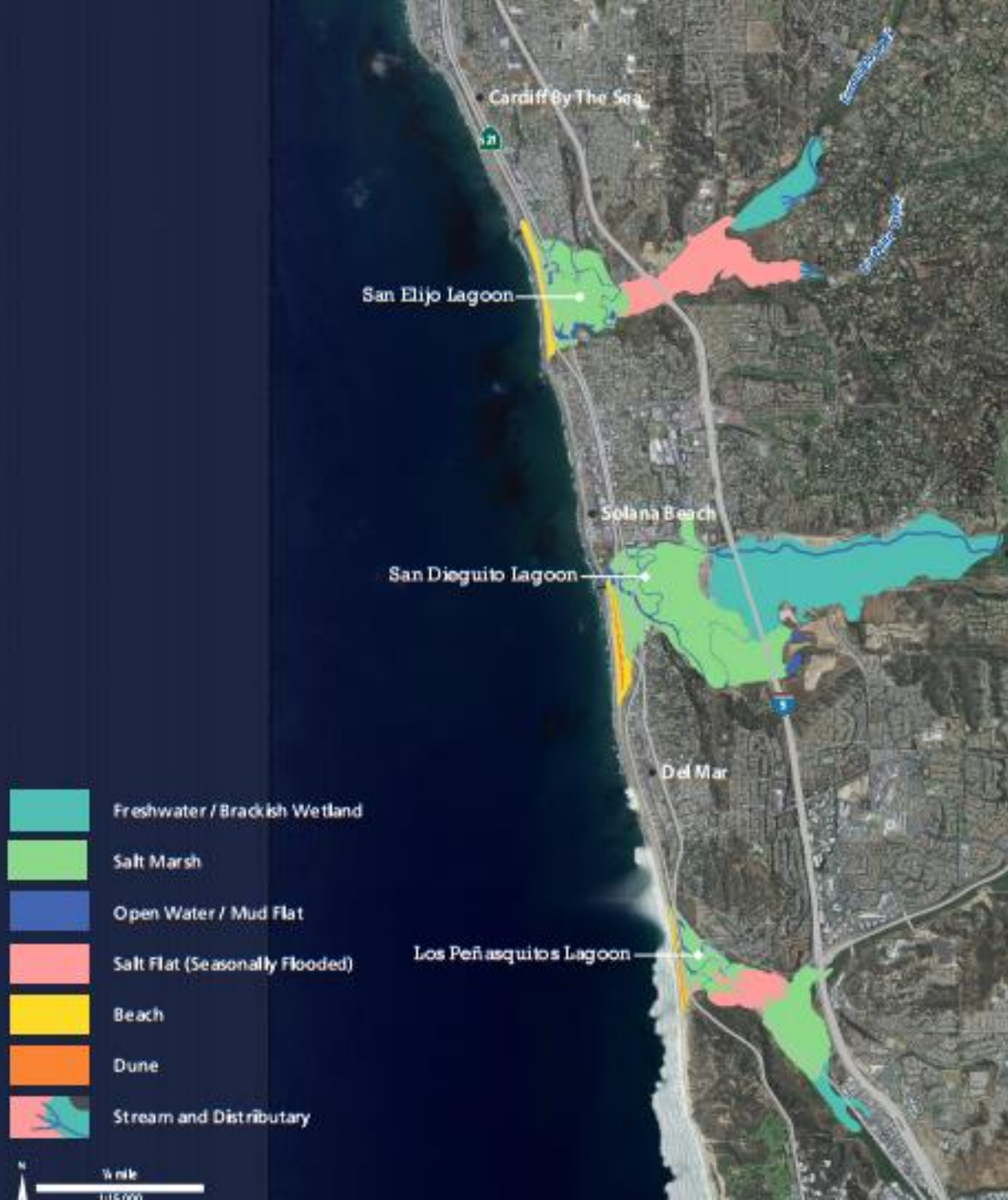
Cardiff State Beach Living Shoreline Project
(City of Encinitas)

Outer Coast

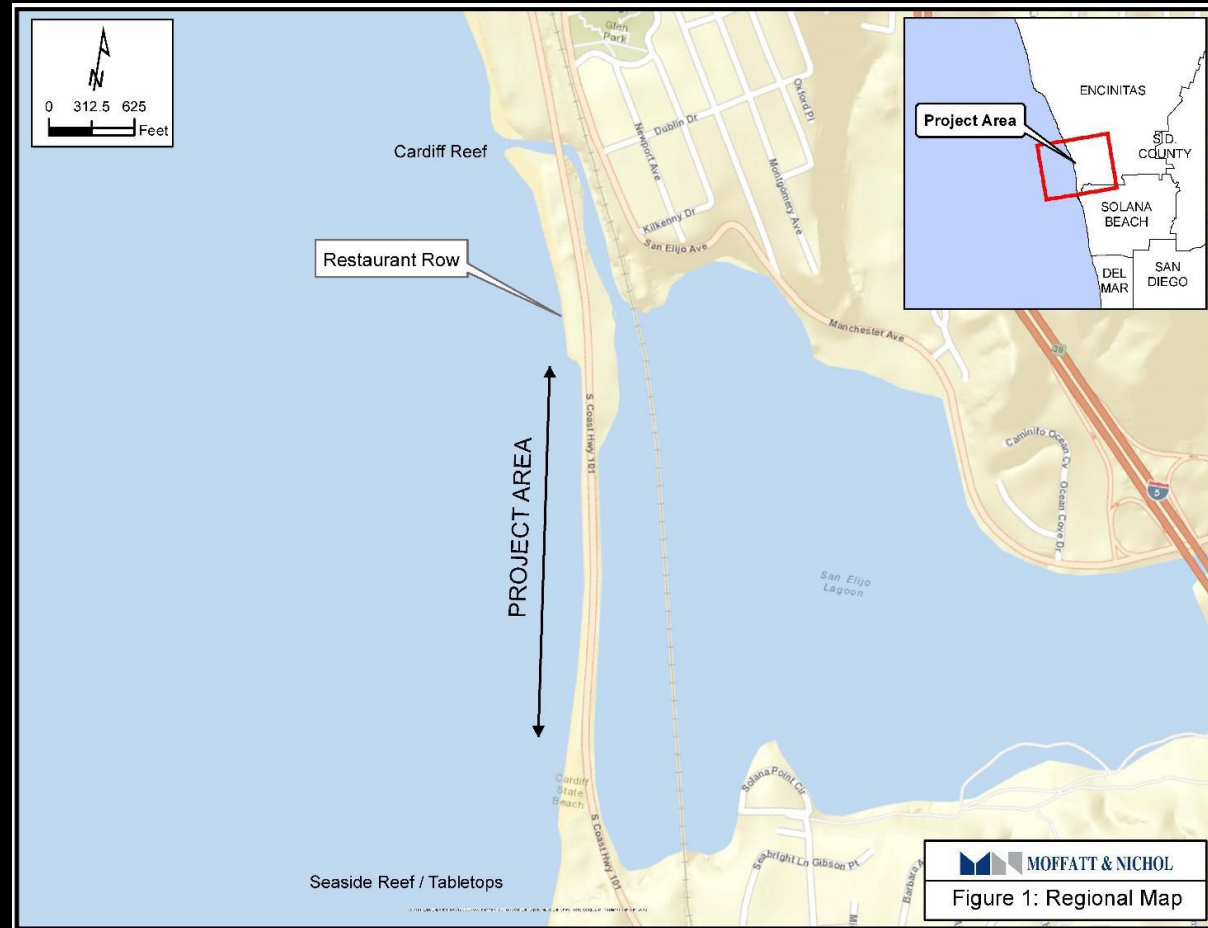
- 5-7' tidal range throughout state
- Waves can exceed 30M
- Storm surge 1-2 feet
- Beaches change seasonally
- Periodic El Niño events
- 10% of coastline is armored



Historical Coastal Dune Habitat Lost



Cardiff State Beach & Highway 101



Cardiff Beach Present Day



Living Shoreline Visualization



Not much space - Critical infrastructure

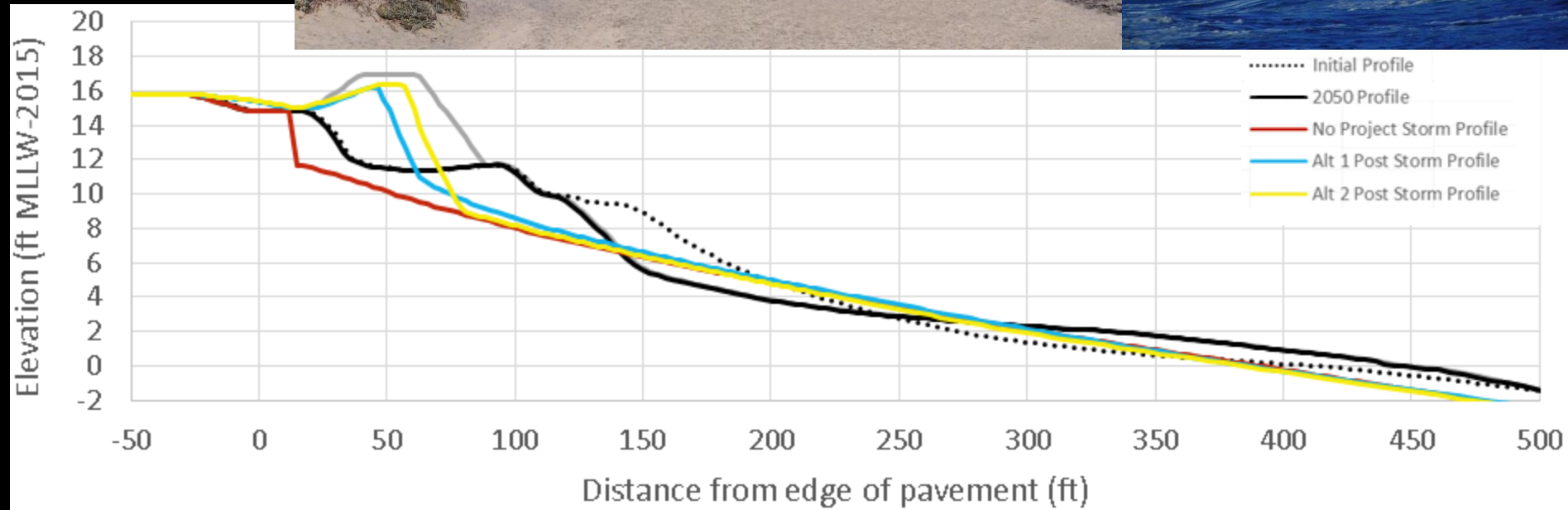




Rip Rap & Cobble



Sea Level Rise & Storm Modeling



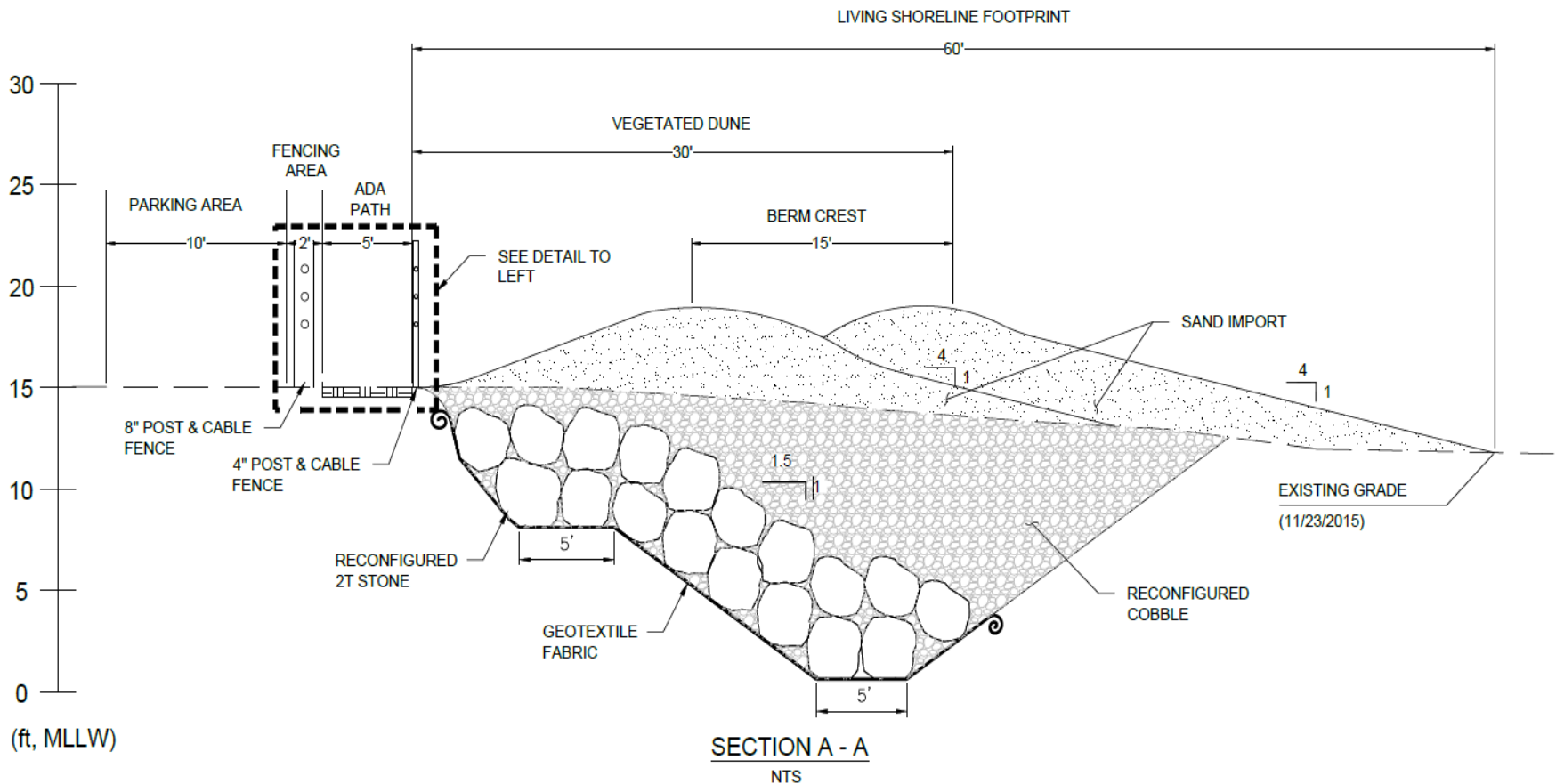
Beach Nourishment



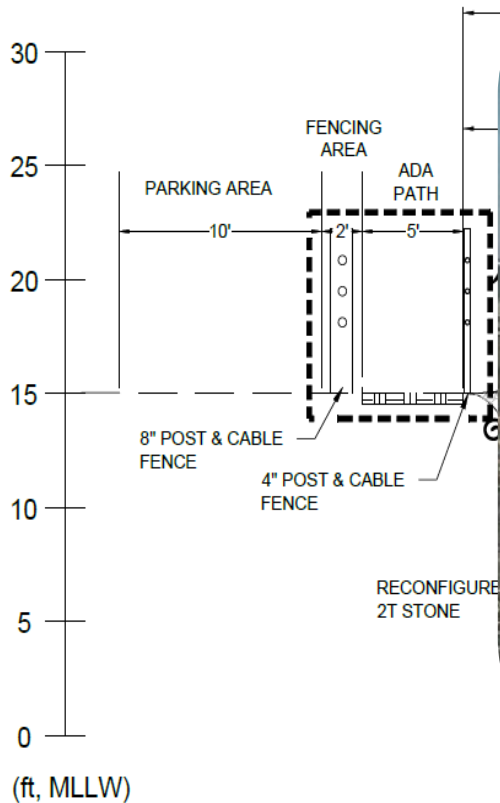
Ludka, B.C., Gallien, T.W., Crosby, S.C., Guza, R.T., 2016. Mid-El Niño erosion at nourished and unnourished southern California beaches. *Geophysical Research Letters*, 43, 4510-4516. doi: 10.1002/2016GL068612

Cardiff State Beach

Living Shoreline Concept



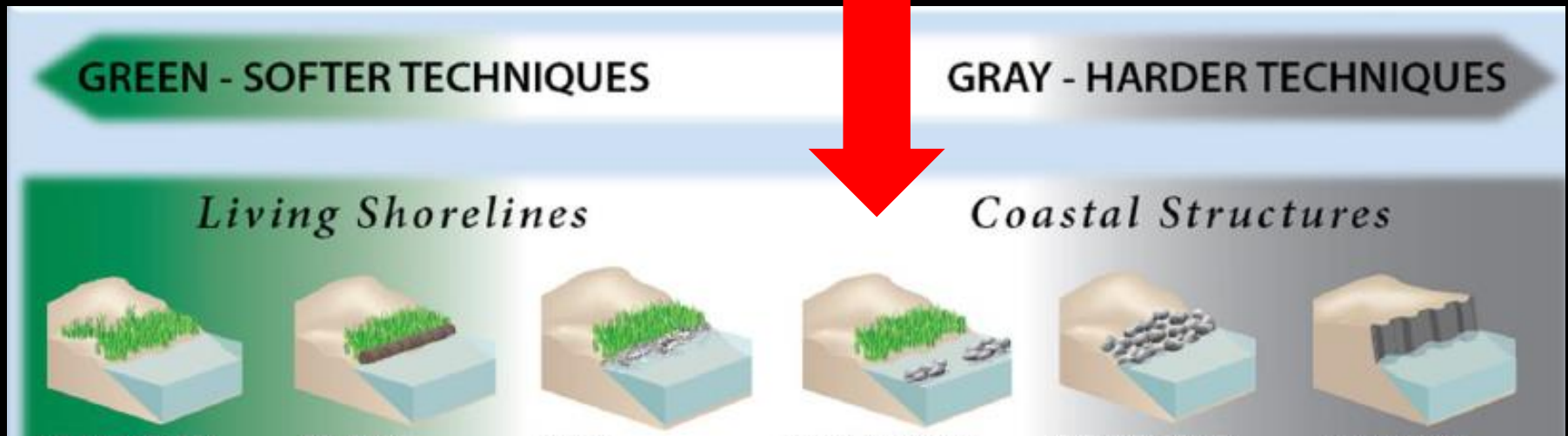
Cardiff State Beach Living Shoreline Concept



SECTION A - A

NTS

Green-Grey Approach



Green-Grey Approach

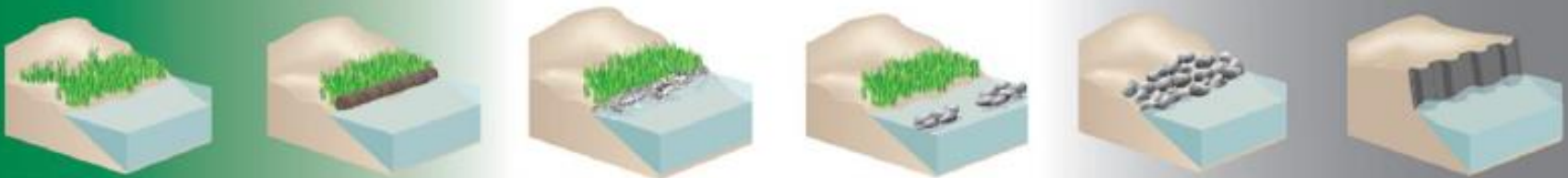


GREEN - SOFTER TECHNIQUES

GRAY - HARDER TECHNIQUES

Living Shorelines

Coastal Structures



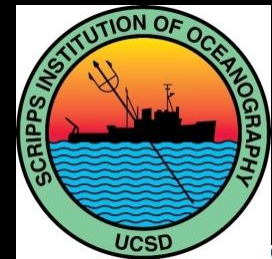
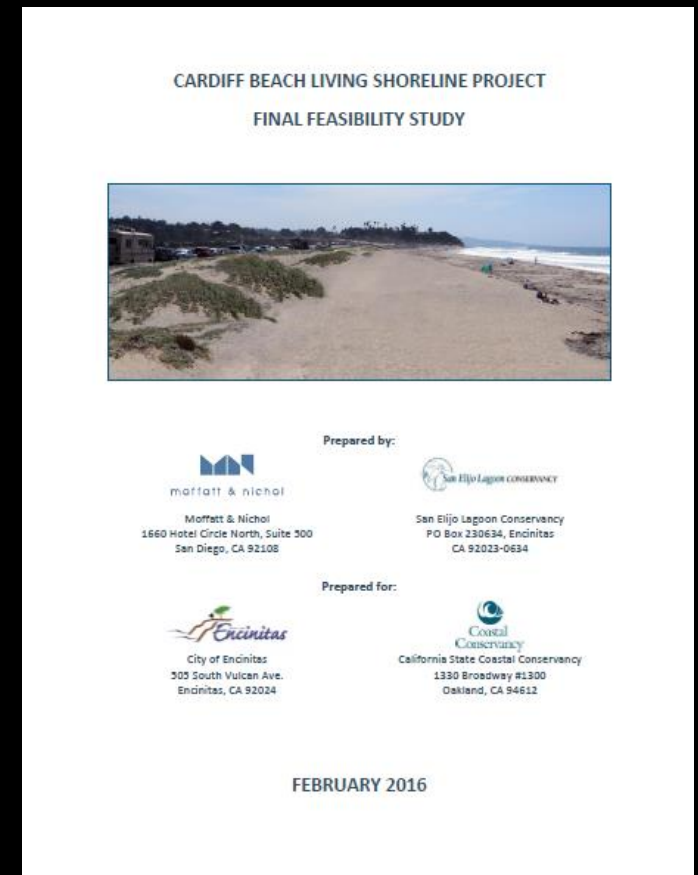


Pilot Project Monitoring



Next Steps

- Project fully funded
- Final Design
- **Permitting**
 - Major Use Permit
 - Coastal Development Permit
 - Biological Opinion
 - Right of Entry Permit
- **Monitoring** Plan
 - Physical
 - Biological
- **Construct** early 2018





Thank You



Evyan Borgnis Sloane
Evyan.Sloane@scc.ca.gov

Living Shorelines – Tidal Wetlands



Joel Gerwein



State of California

Coastal Conservancy

White Slough Restoration (SCC, USFWS)



Bolinas Lagoon Wetland Enhancement/SLR Adaptation (Marin County Open Space)

Seal Beach Sediment Augmentation (Southwest Wetlands Interpretive Association)

Arcata Bay Adaptation Measures (City of Arcata)



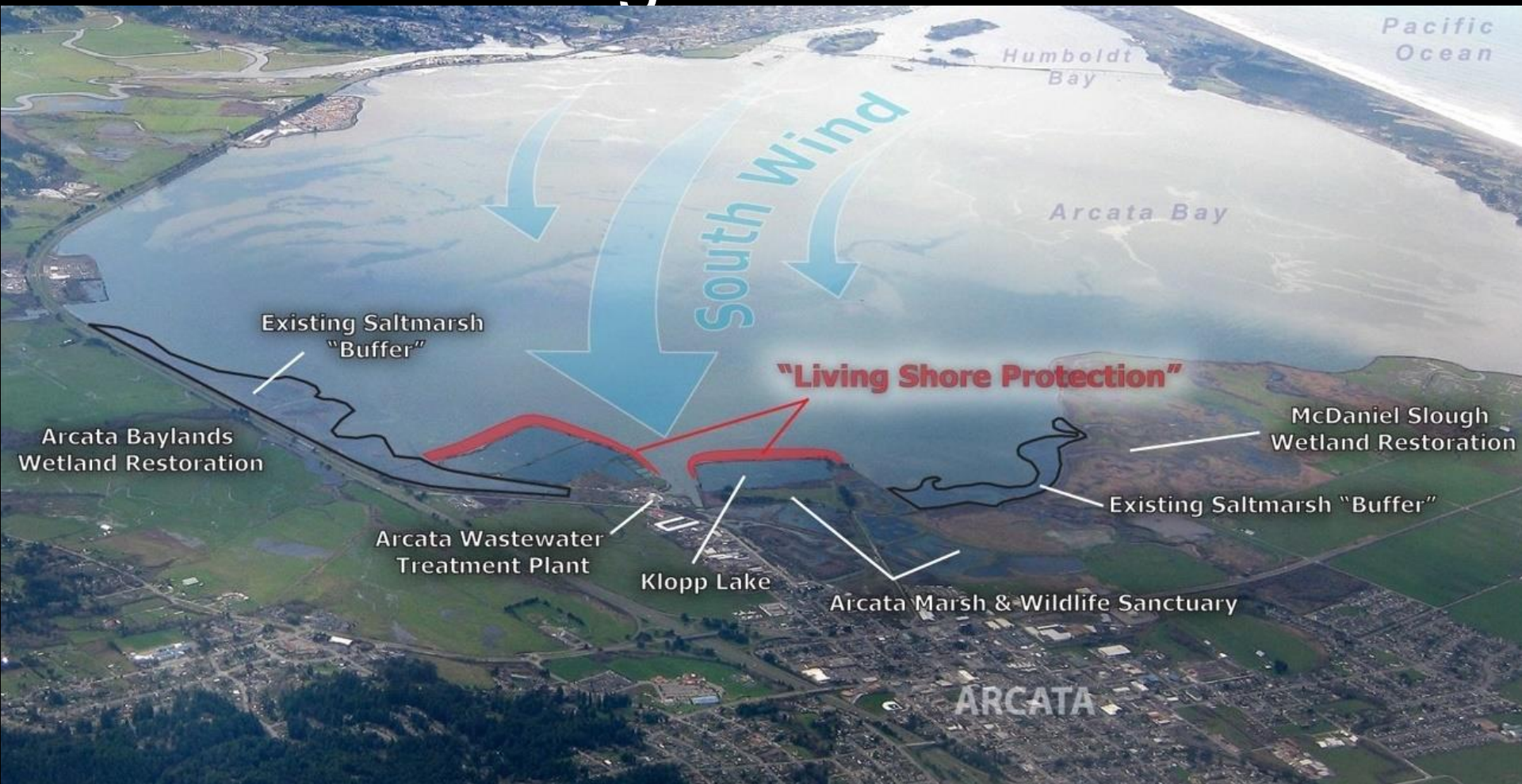
South Bay Salt Ponds (SCC and Partners)



Project Location



Considering Local Conditions



Physical Elements
Habitat

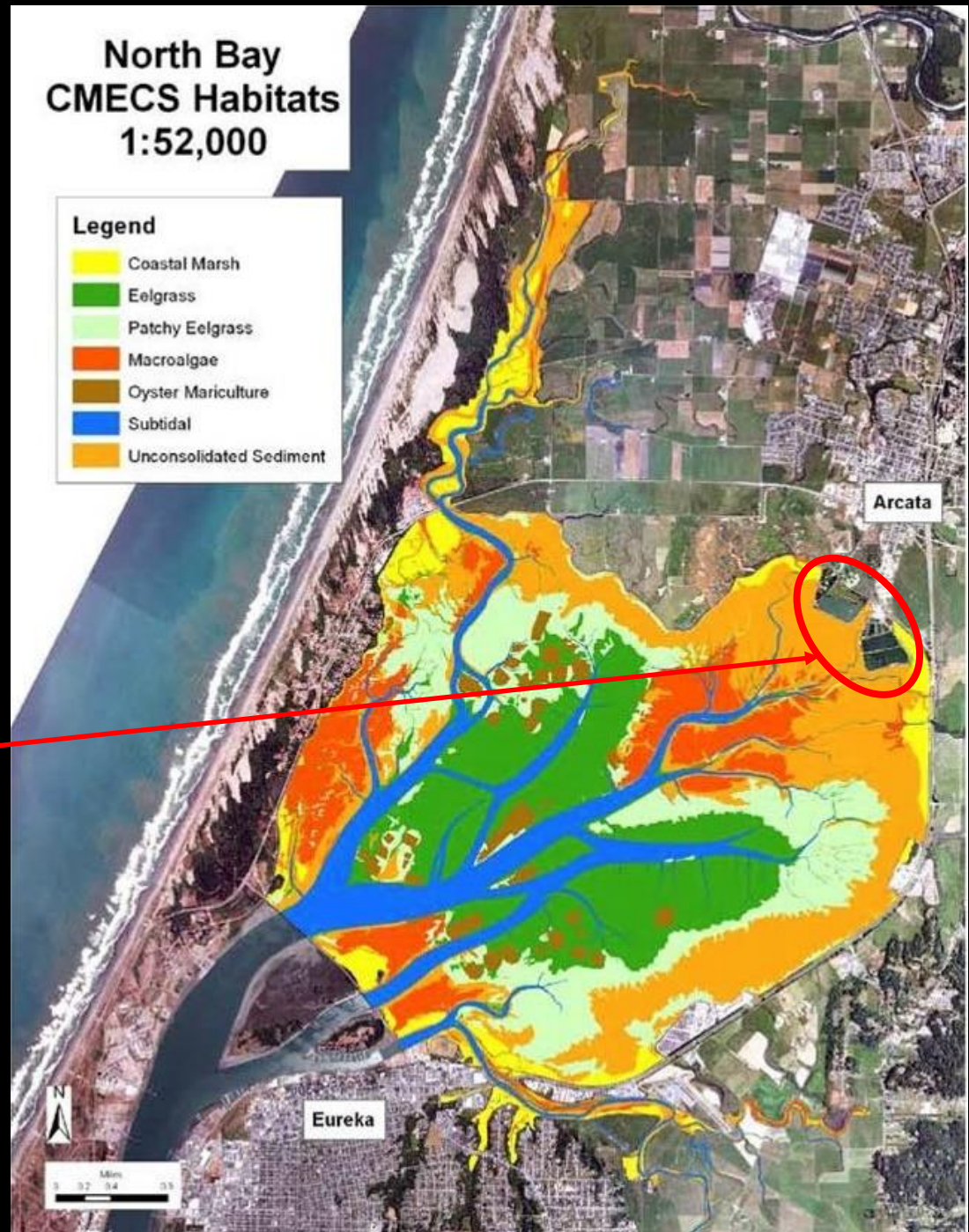
Hardscape Infrastructure
Aesthetics/ Community



Benthic Habitat Distribution

Yellow=Marshes
Light
Orange=Mudflat

Project site in mudflats





Narrow band of fringe marsh and mudflats



Barrier Heights Arcata Bay Range 3' to 14+'

Upper Arcata Bay Reach
Tidal Elevation 2015-2050



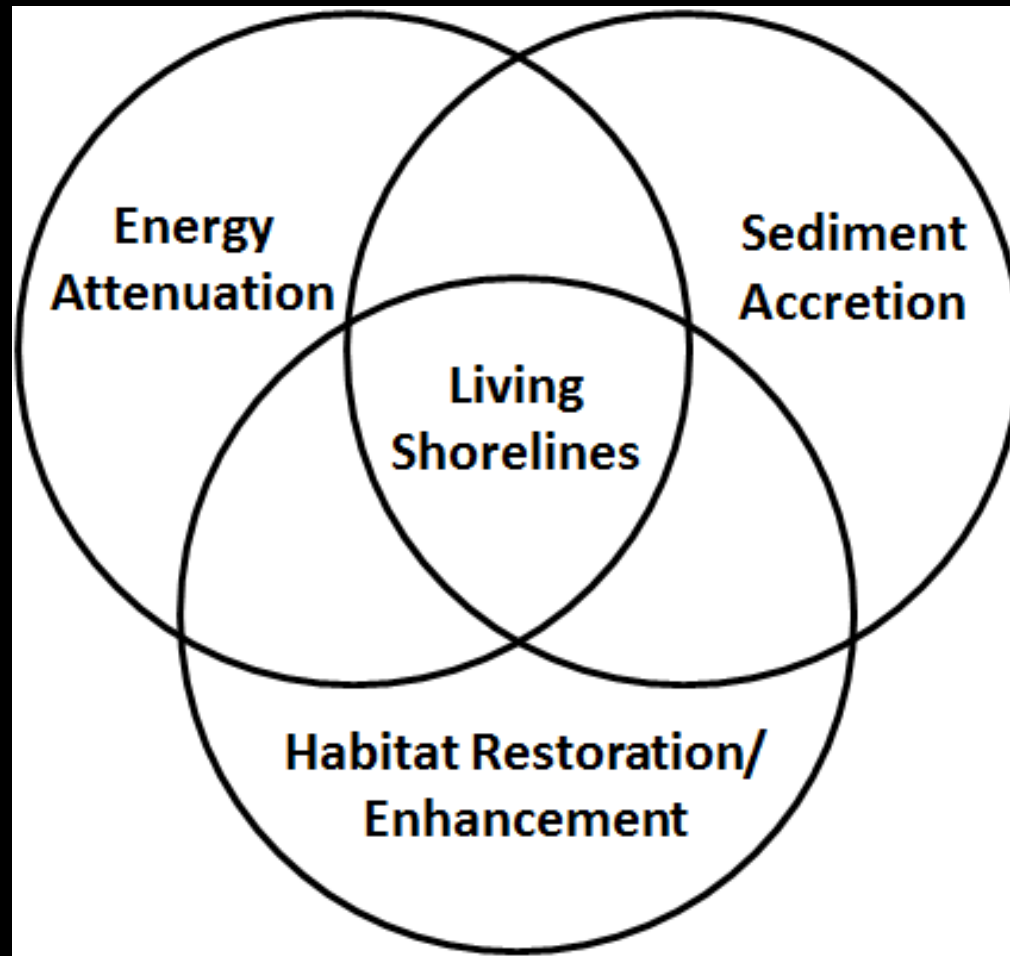
Community Priorities in Design Considerations

- 
- A photograph of a field of purple flowers, likely Salvia, in the foreground. In the background, there is a line of green trees under a bright sky. The text is overlaid on the left side of the image.
- 1) Natural Resources (Dunes, Marshes, Species of Concern)
 - 2) Infrastructure/Public Services
 - 3) Agricultural Lands
 - 4) Stormwater/wastewater

Tech Advisory Committee Ranking

Weight (1-10)	Categories	Criteria
	Social	
9	Aesthetics	Minimize visual impairments to the landscape or habitat areas such that the natural scenery of the marsh is maintained.
10	Public Health & Safety	Minimize public health and safety concerns during construction, planting, or monitoring of the living shoreline.
9	Community Outreach & Involvement	Maximize community involvement in the pilot project development and implementation, through decision-making and educational materials regarding the benefits of Living Shorelines.
	Economic	
9	Local Sourcing	Minimize distance travelled from material source location to project site. Maximize local expertise involved in project planning and implementation.
10	O&M	Minimize operation and maintenance costs associated with pilot project implementation.
9	Capital Costs	Minimize initial costs of materials and construction. Maximize opportunities for grants and other sources of outside funding to support capital costs.
	Environmental	
10	Habitat Value	Maximize biodiversity in all habitats (e.g. salt water marsh, mudflats) such that coastal wetlands remain a valuable place for wildlife vitality and other ecosystem services.
10	Sediment Accretion	Maximize the rate of soil accretion due to sedimentation in areas where fringe salt marsh is desired.
10	Wave & Energy Attenuation	Maximize protection of public resources and assets from erosion and storm surges that may cause damage to the Arcata community through wave attenuation. This includes the Arcata WWTP, Klopp Lake, and the adjacent Arcata Marsh and Wildlife Sanctuary.
10	Water Quality	Minimize negative water quality effects that occur during construction and implementation of the project.
8	Carbon Sequestration	Maximize the amount of carbon capture and storage through applicable plant, soil and other material selection.

Living Shoreline Components



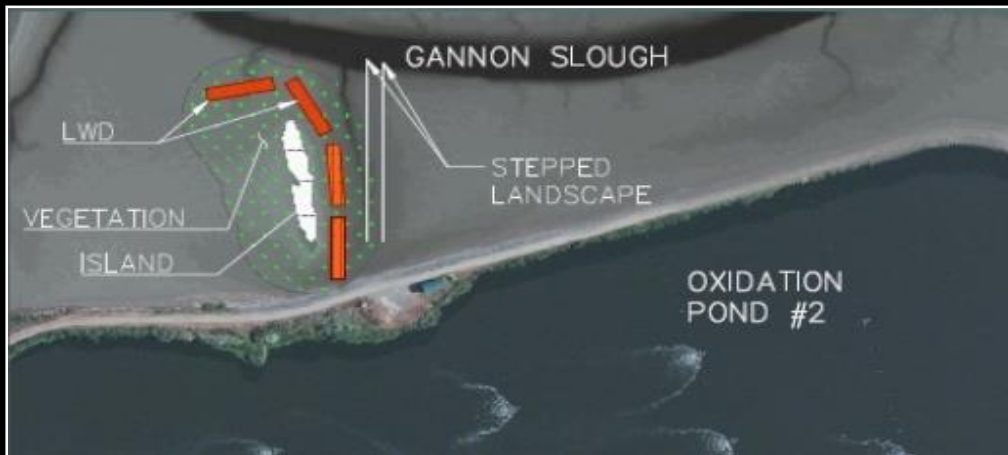
Design Exploration



Rocks, oyster reefs

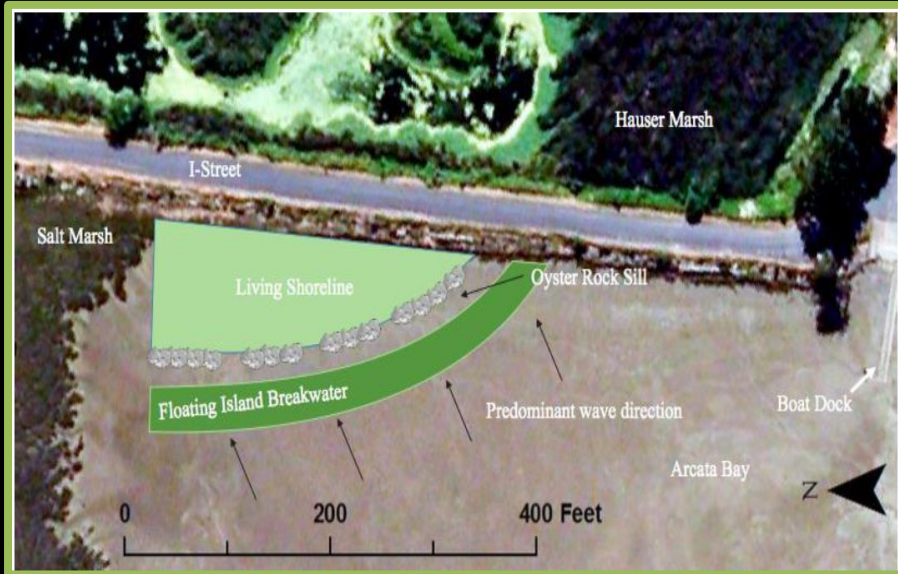


Coir logs

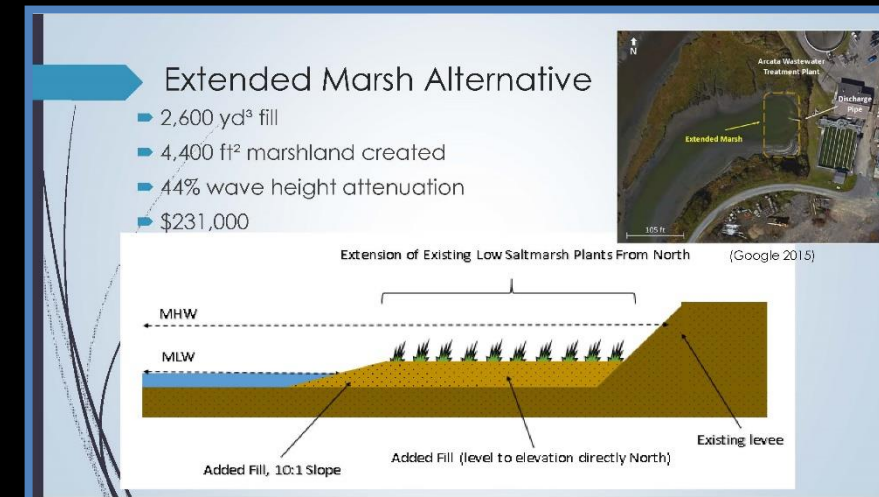
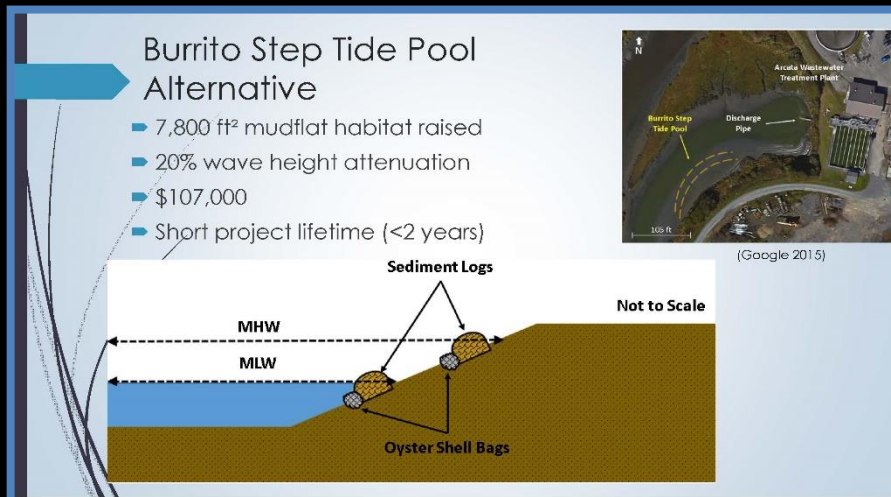
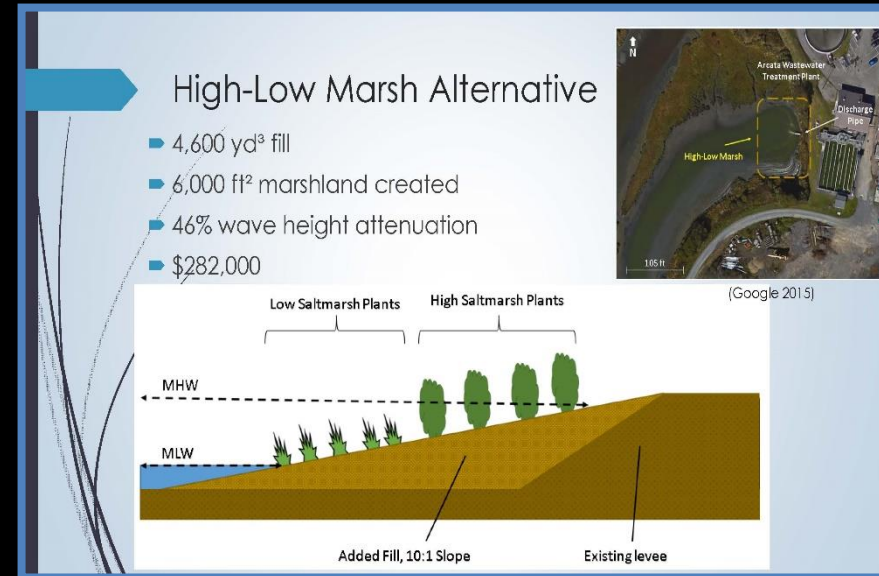


Large woody debris

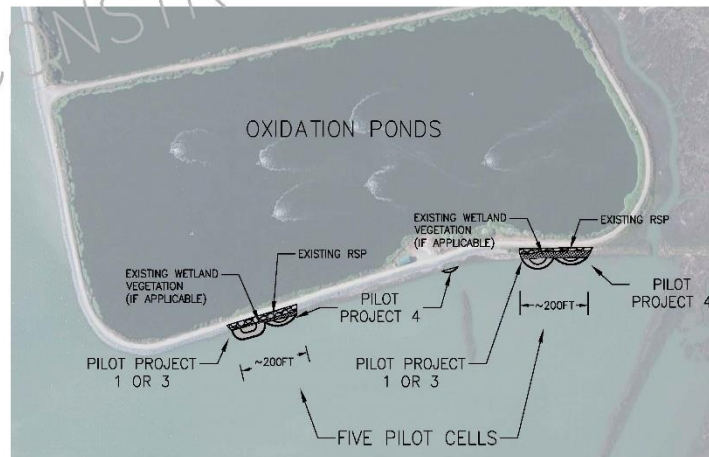
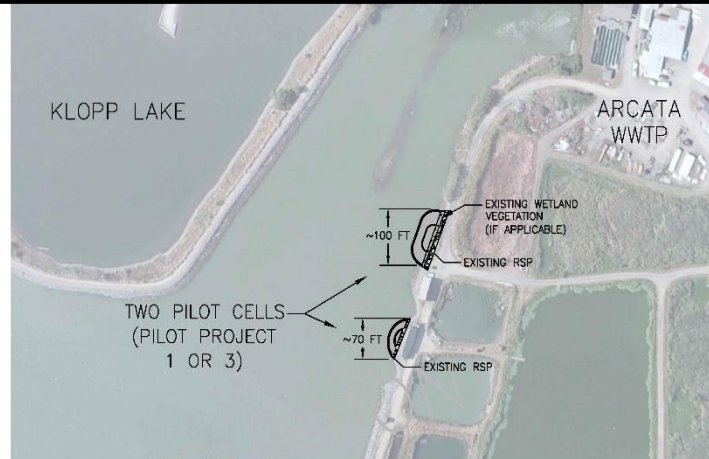
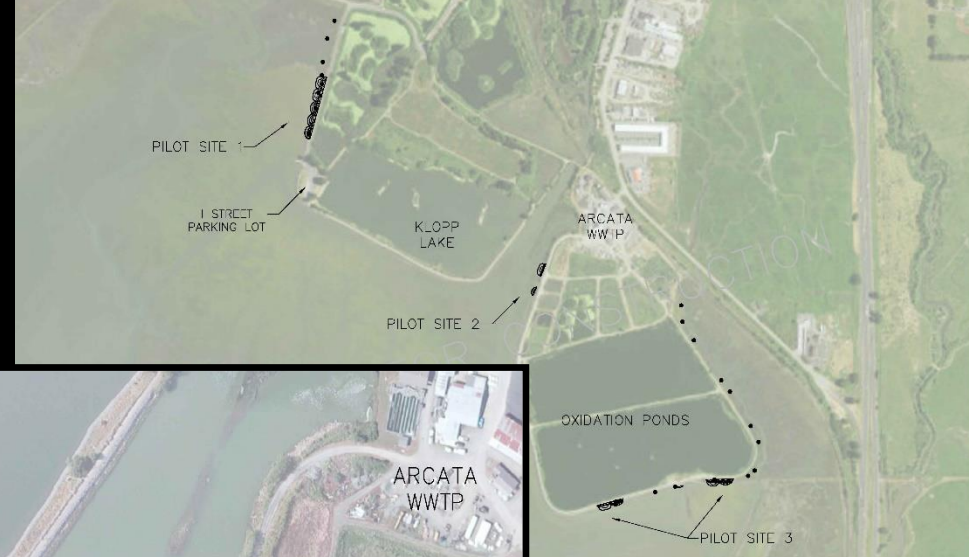
Some Conceptual Designs



Concepts – Salt marsh veg / breakwater Horizontal Levee variations



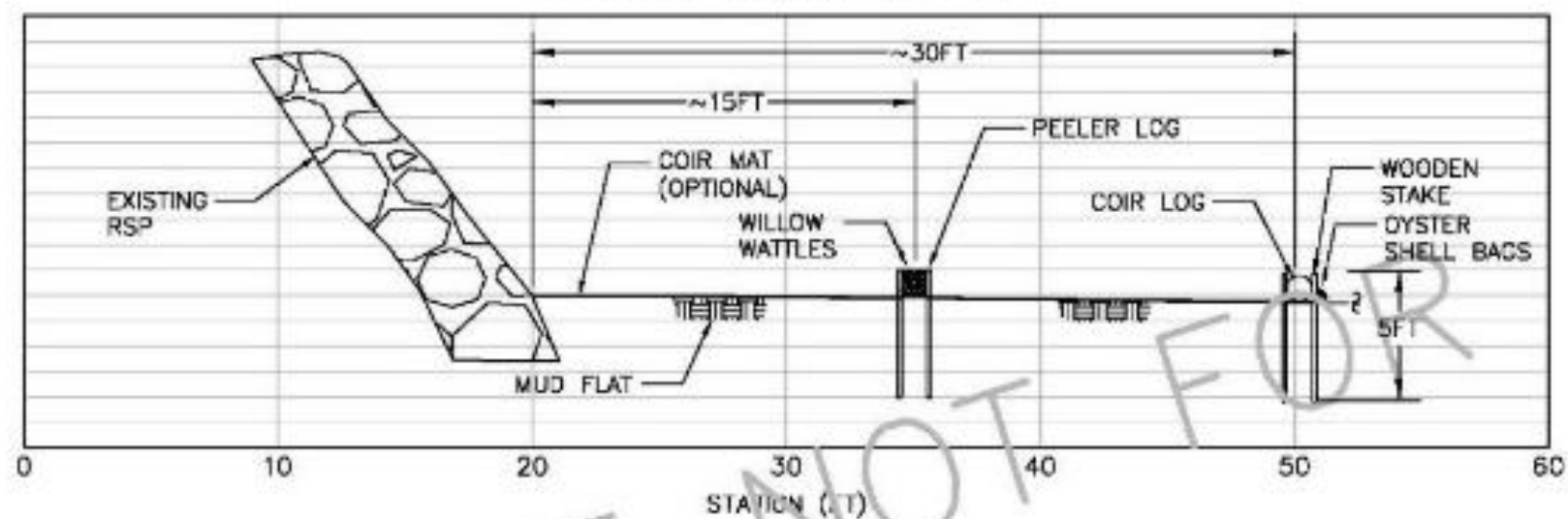
City of Arcata Living Shoreline Concept Design Plans (2016)

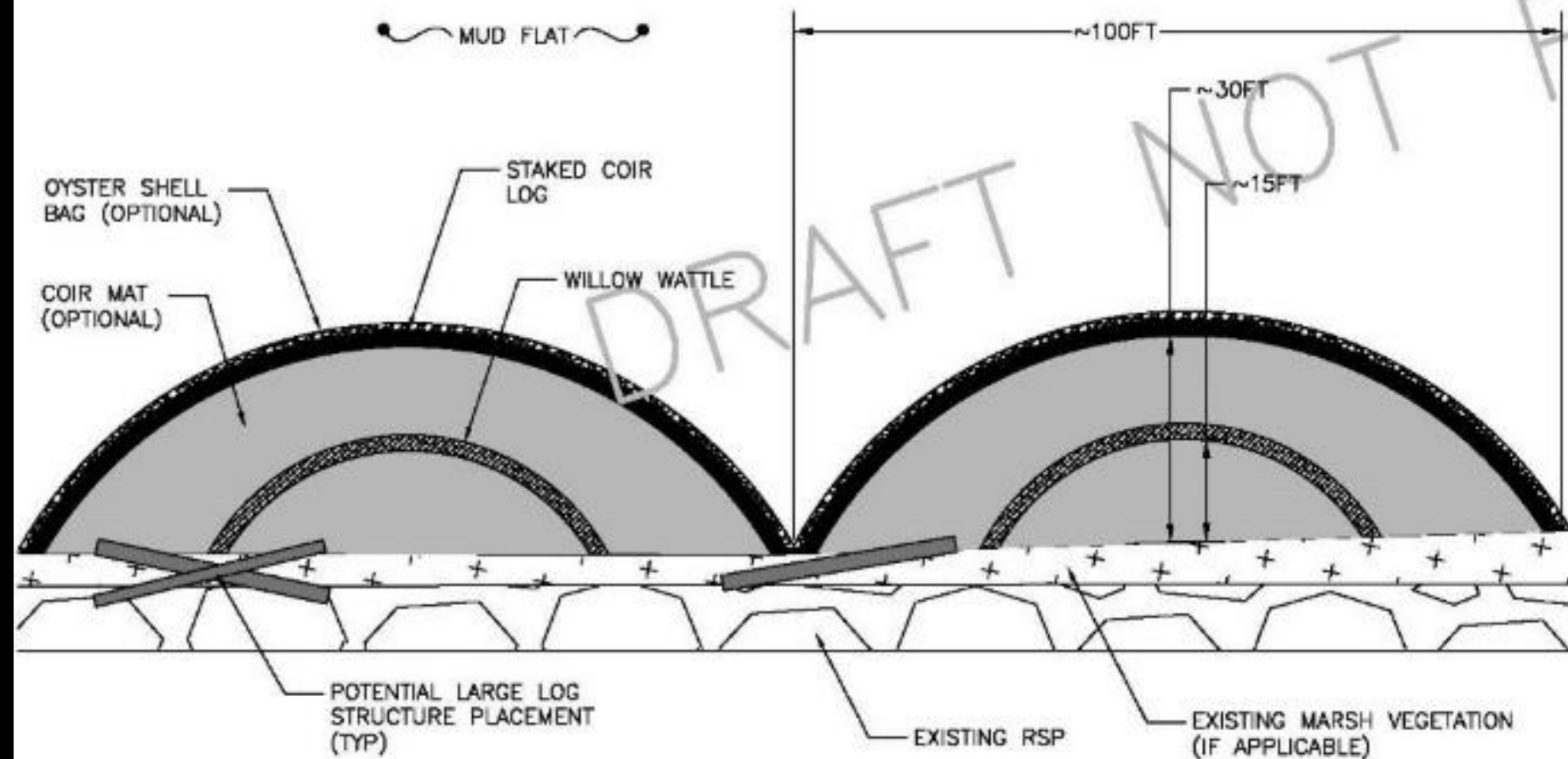


- Coir logs
- Oyster reefs
- Large wood

FOR PERMITTING PURPOSES ONLY

PILOT PROJECT 3

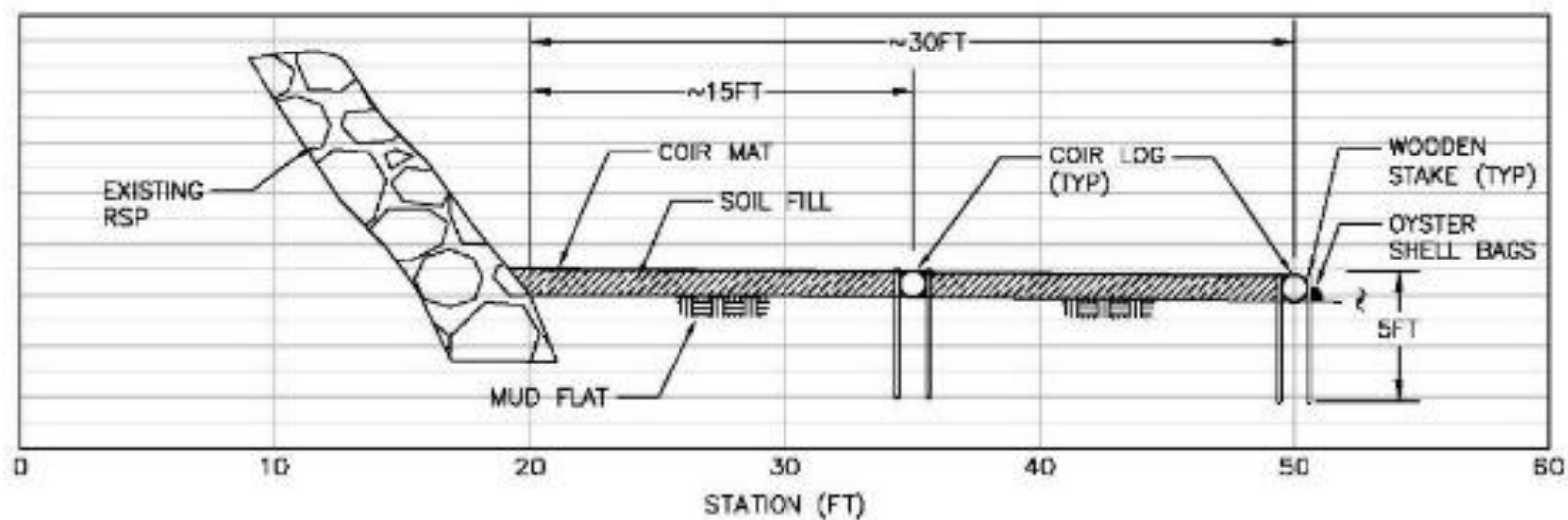


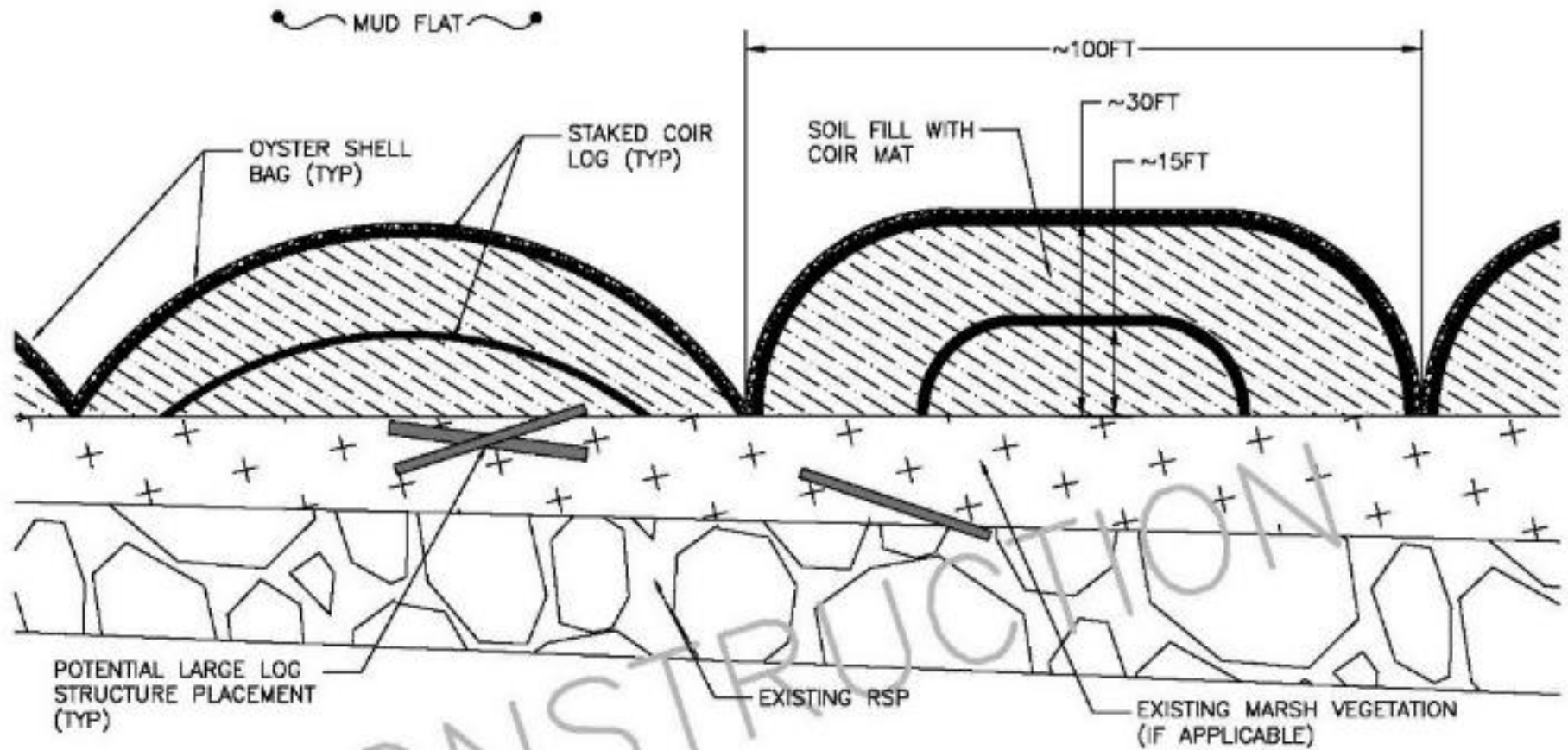


PILOT PROJECT 3 PLAN VIEW DETAIL

SCALE : NTS

PILOT PROJECT 2



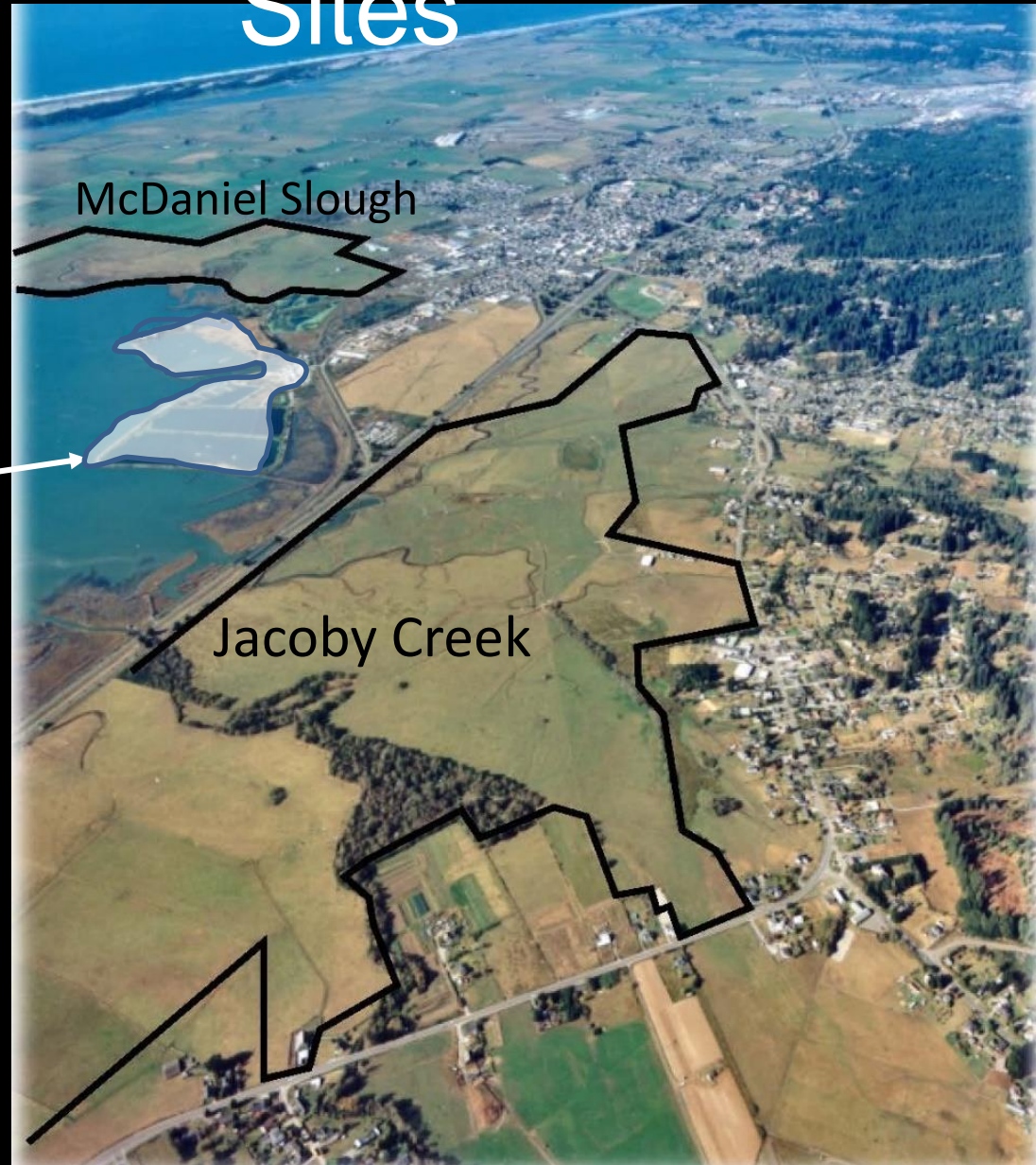


PILOT PROJECT 2 PLAN VIEW DETAIL

SCALE : NTS

Adjacent Marsh Restoration Sites

Project site



McDaniel Slough

Jacoby Creek

White Slough Restoration
(SCC, USFWS)



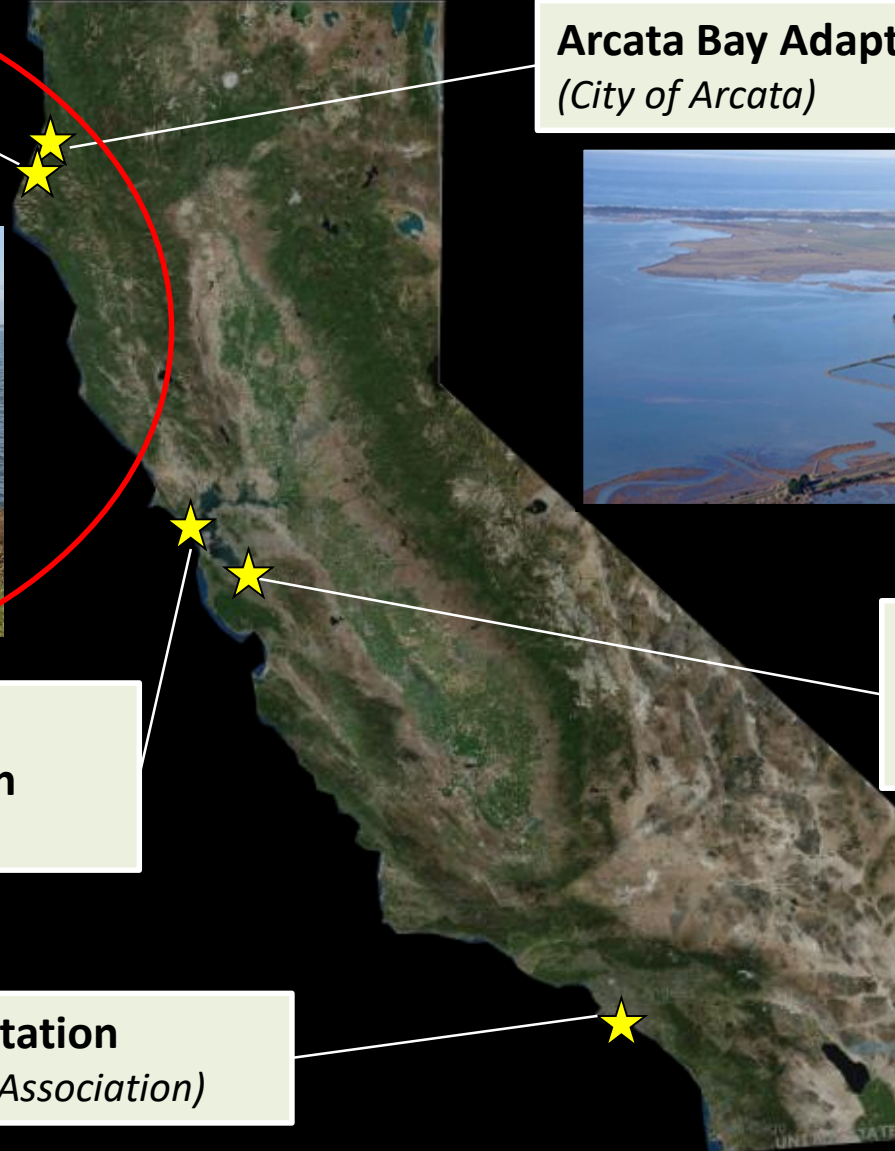
Bolinas Lagoon Wetland Enhancement/SLR Adaptation
(Marin County Open Space)

Arcata Bay Adaptation Measures
(City of Arcata)



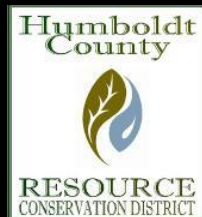
South Bay Salt Ponds
(SCC and Partners)

Seal Beach Sediment Augmentation
(Southwest Wetlands Interpretive Association)



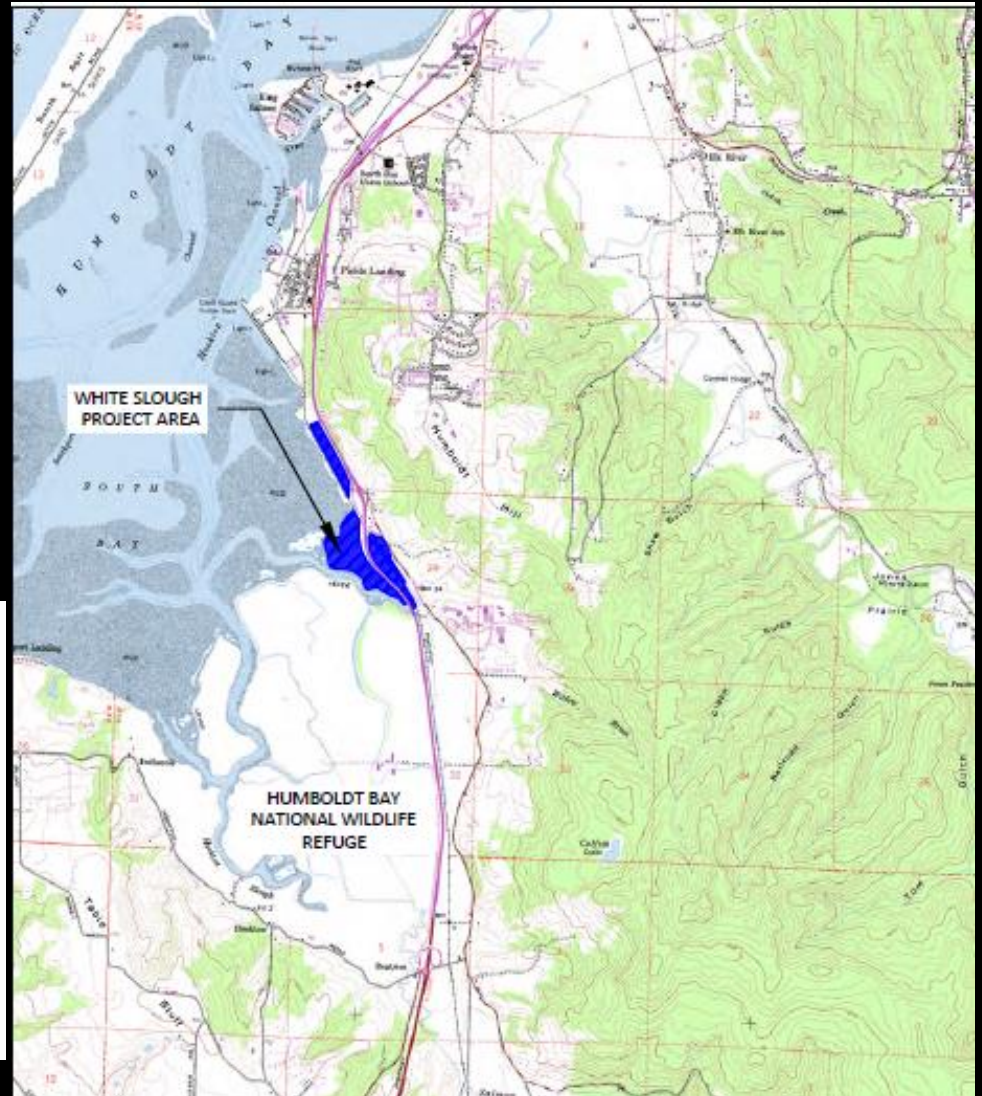
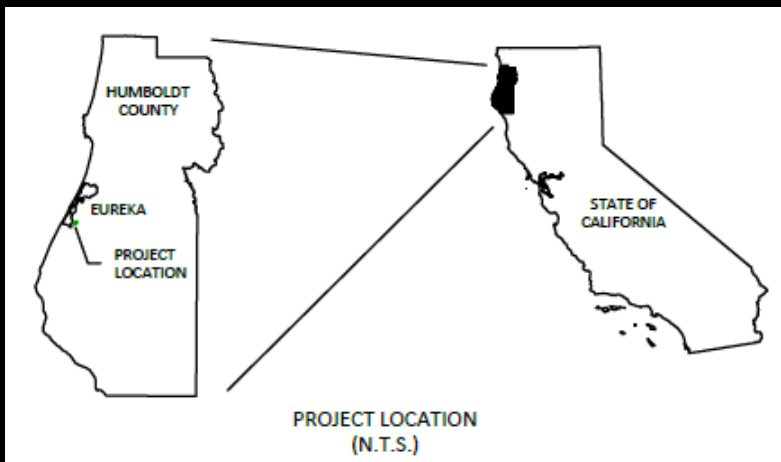
White Slough Restoration

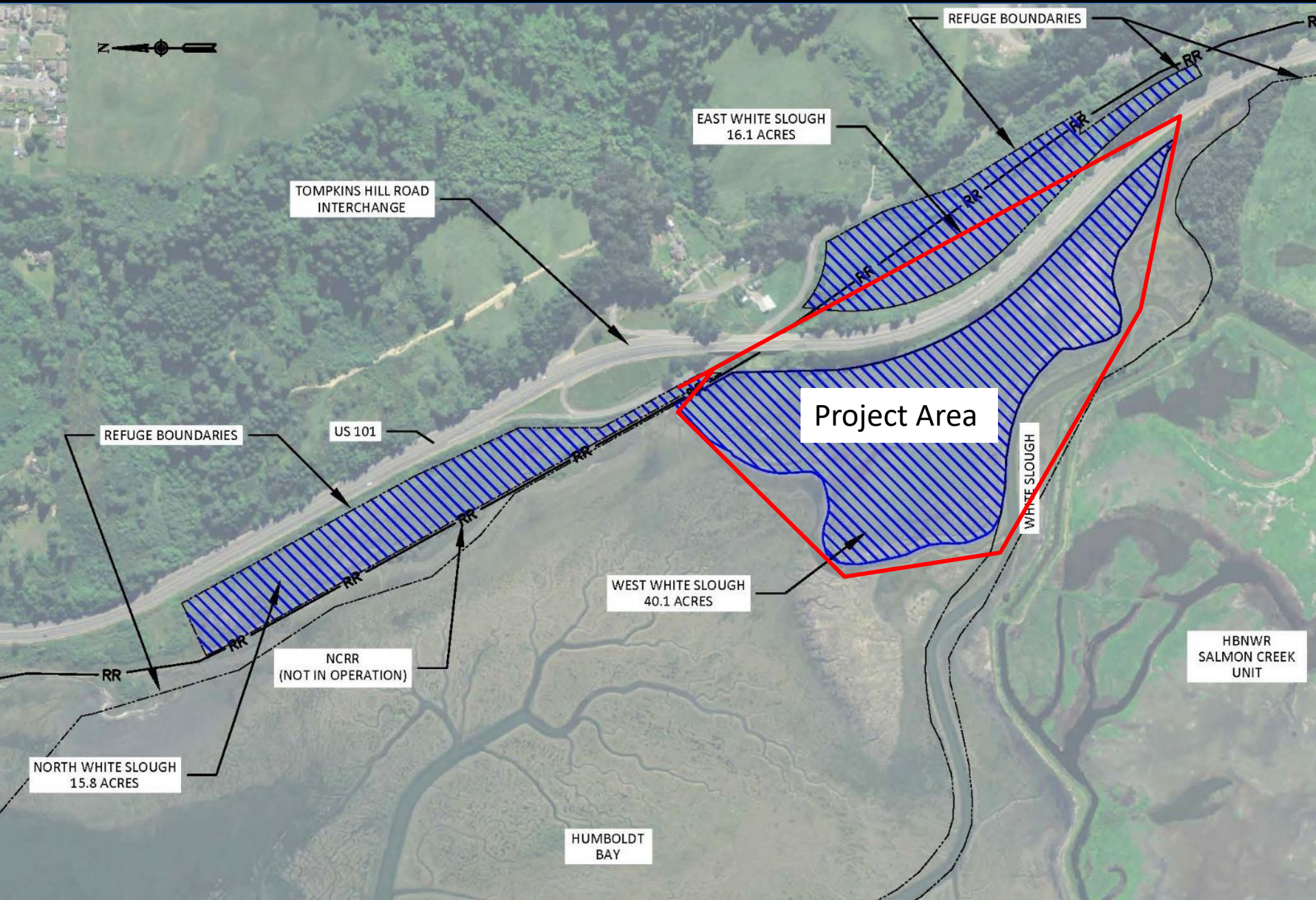
Subsided
40 acre
brackish
marsh
behind
failing
dikes



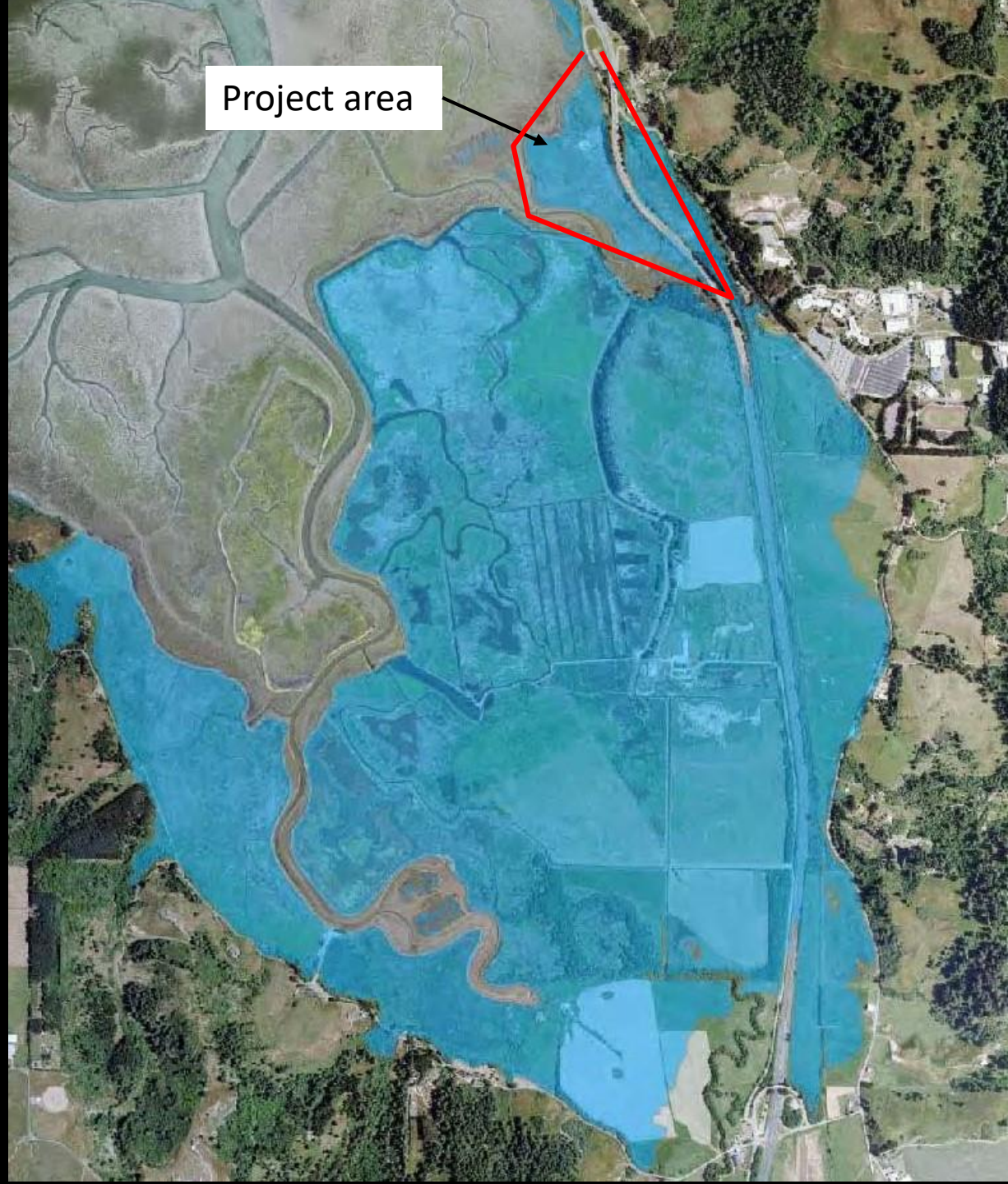
Project location

- Adjacent to Highway 101 and College of the Redwoods access road





Inundation
with MMMW
+ 100 yr
stillwater
level (9.99
ft)



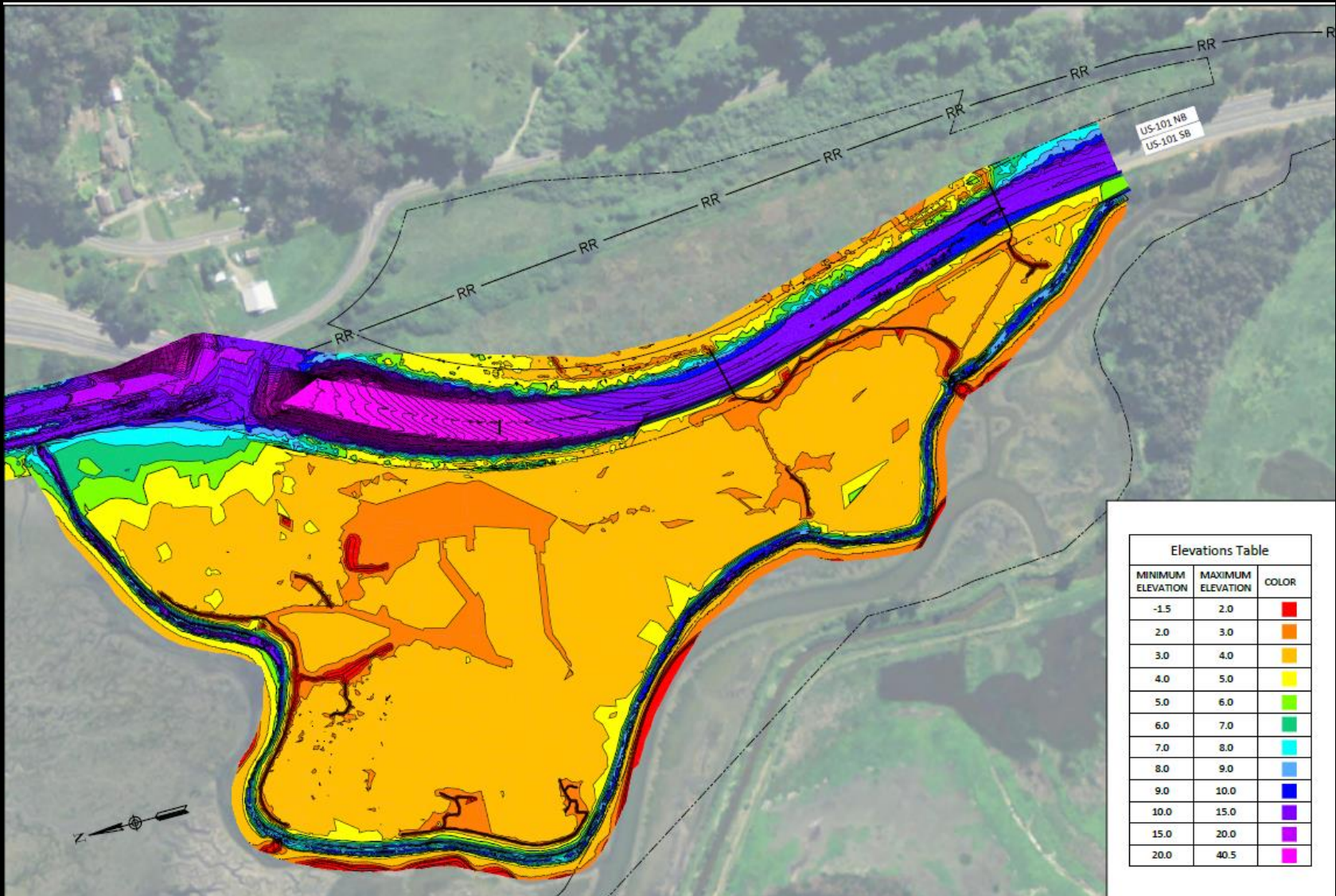


Pre-project Levee Breach

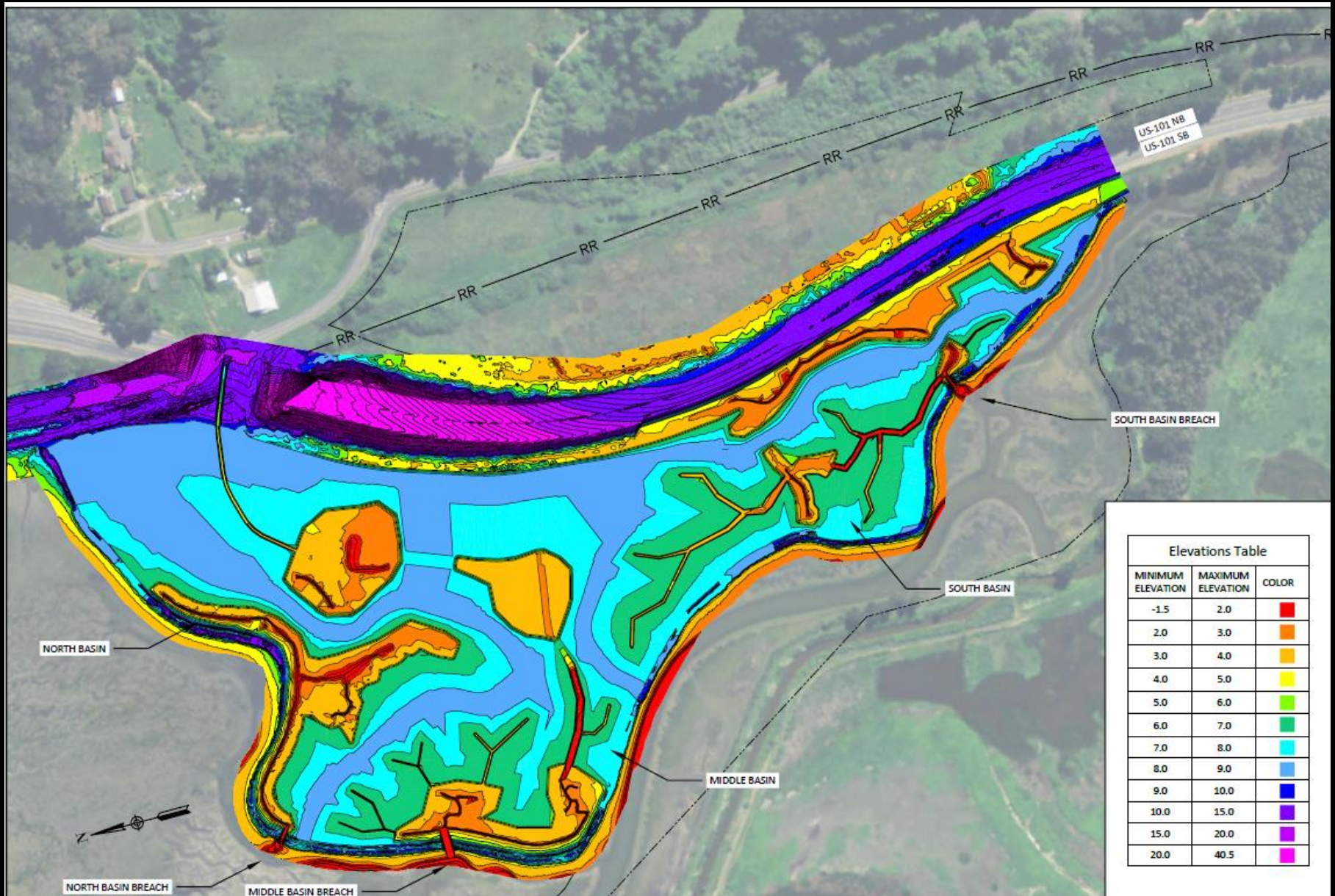




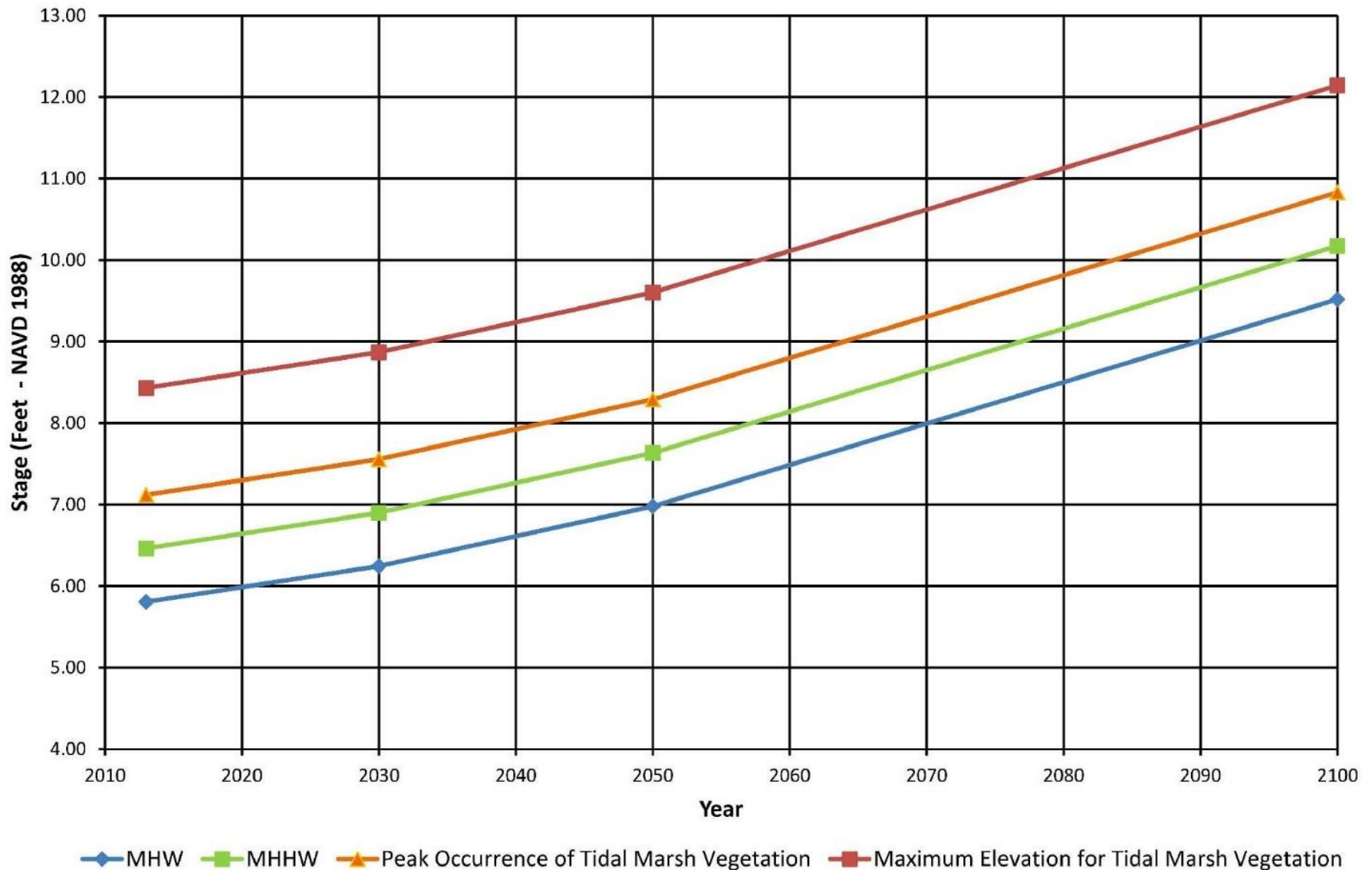
Existing topography



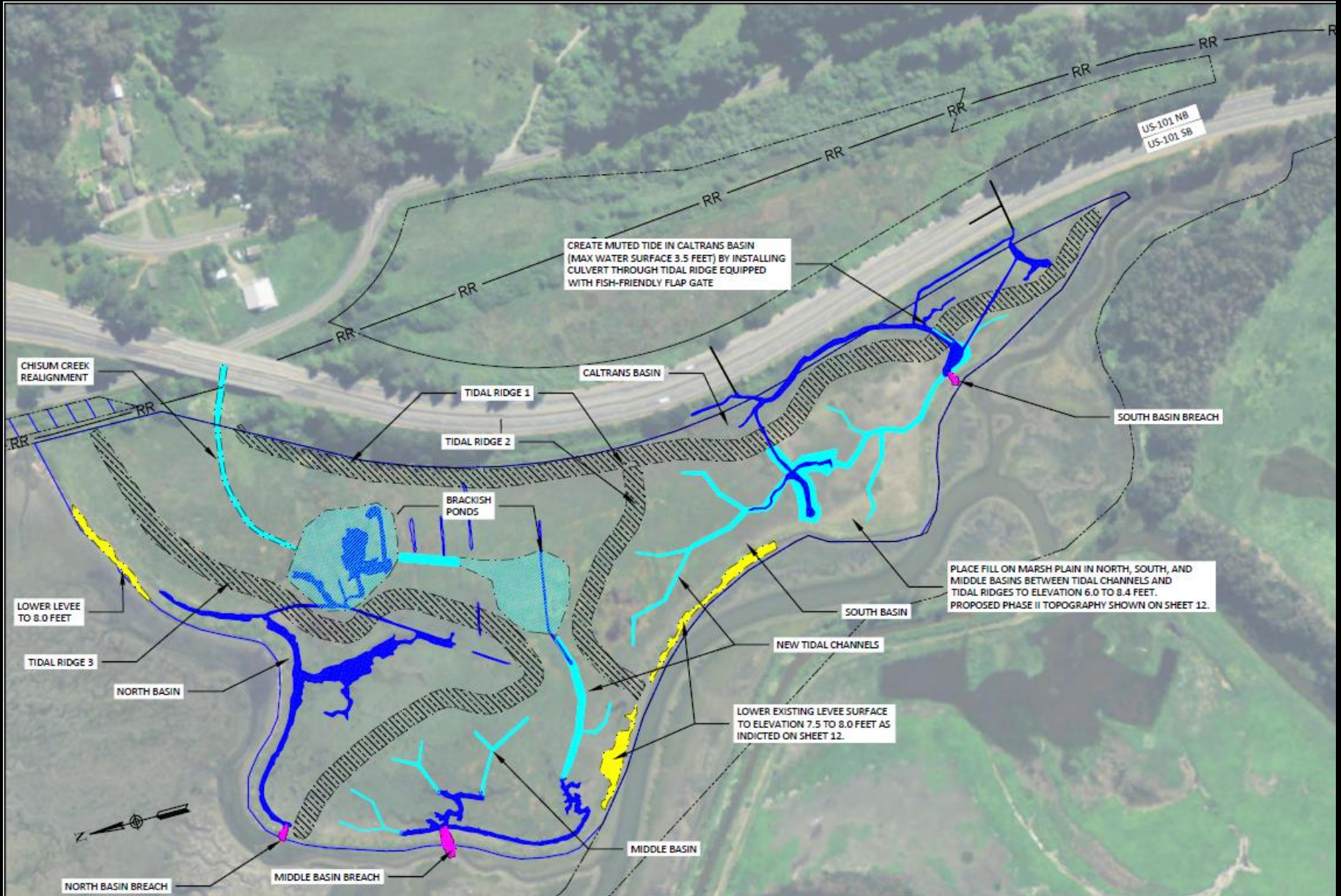
Proposed topography



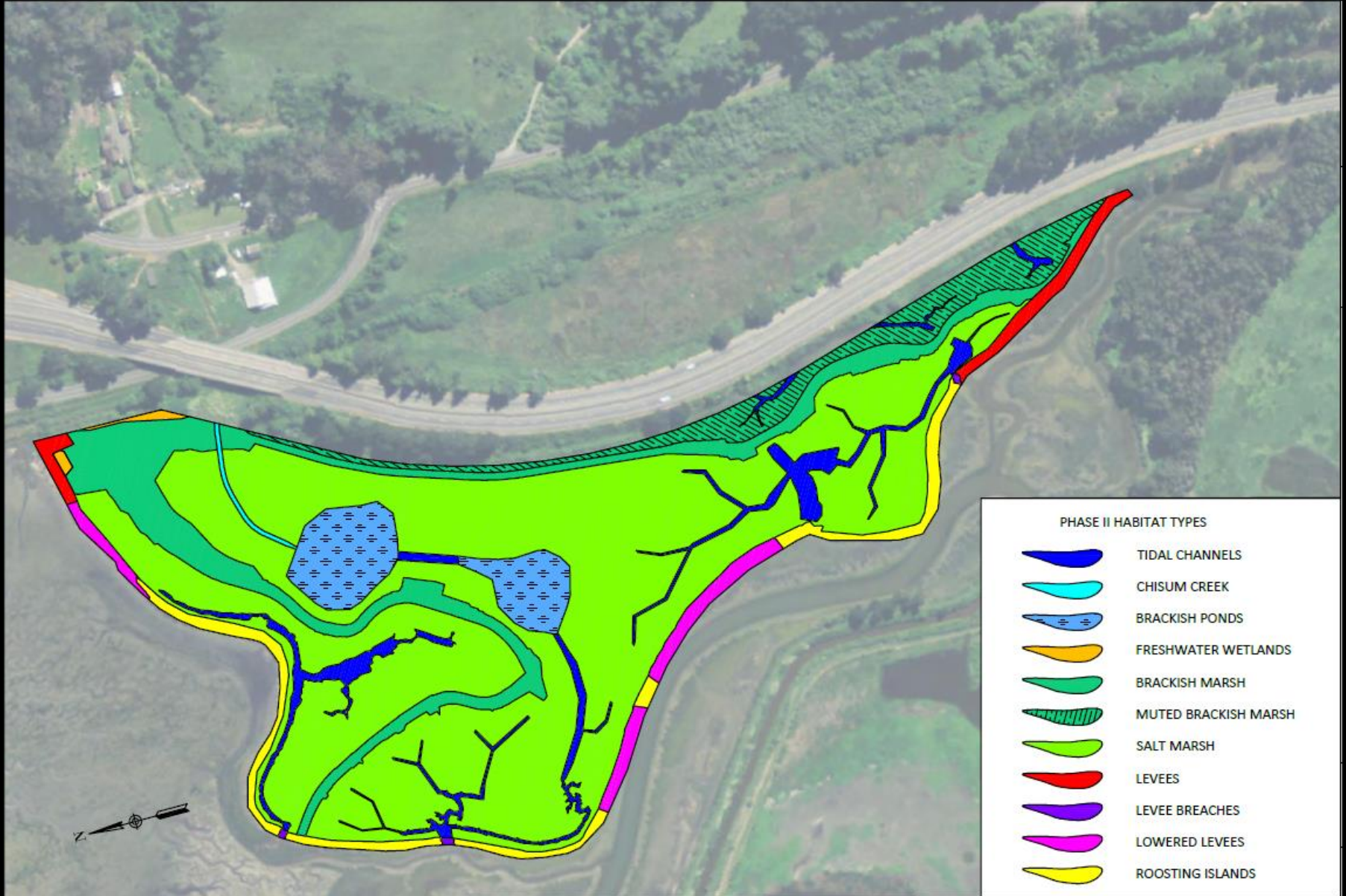
White Slough Tidal Datum Elevations Under Mean Estimate of Sea Level Rise



Project Actions



Post-Project Habitat Types



White Slough Restoration: Phase 1 2015

September



November



Project constraints

- Caltrans engineering specs required a setback of the project
- Finding and permitting sediment for beneficial reuse is difficult and time consuming

Is this a Living Shorelines Project, or “just” another tidal marsh restoration project?

Project benefits

- Marsh habitat
- Wave attenuation to protect highway embankment and access road
- Increased accretion

ACOE Nationwide Permit 54- Living Shorelines

Policy Support in California

Exec Order B-30-15- *Prioritize natural infrastructure solutions*

SB 246: *Integrated Climate Adaptation and Resiliency Program*

- Safeguarding CA Plan
- 4th Climate Assessment
- CA Coastal Commission
- CA Coastal Conservancy
- SF Bay BCDC



Very few CA projects and even less published data...

Early state of science, driven by climate adaptation

Regional Landscape Planning

Need to Pilot- BMP's & Design Criteria Needed

Increased capacity needed on all fronts

- design
- permitting
- materials and fabrication
- construction
- monitoring

Land Ownership

Mix of public and private lands



Site Specific Considerations

Existing Uses

Parcel Ownership

Bathymetry

Depths for Habitat Restoration

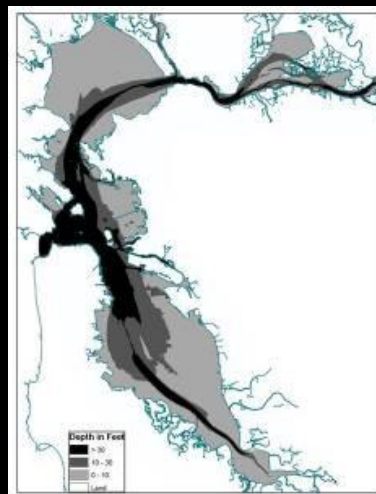
Depths for Access

Orientation to Wind/Waves

Existing Species and Habitats

Sea Level Rise Modeling

Physical Space Required



Regulatory Challenges

- Lack of LS data
- Beneficial Fill
- Suitable Materials
- Construction Methods/ Timing
- Sequential permits
- Long timeframes
- High cost



Threading the Needle

Innovation and Feasibility

Barriers to Innovation:

- Science and data gaps
- Institutional Inertia
- Lack of broader context
- Lack of an advocate



Importance of Feasibility:

- Habitat and species
- Pilot projects – test
- Develop Best Management Practices
- Document success before scaling up
- Monitor long-term benefits and impacts





California is building demonstration projects to address these challenges

Monitor for both physical & biological performance

Habitat potential for green-grey infrastructure

Pilot projects – test & evaluate before scaling up

Thank You !

Questions

State Coastal Conservancy

www.scc.ca.gov

Marilyn Latta

marilyn.latta@scc.ca.gov

Evyan Borgnis Sloane

evyan.sloane@scc.ca.gov

Joel Gerwein

joel.gerwein@scc.ca.gov

